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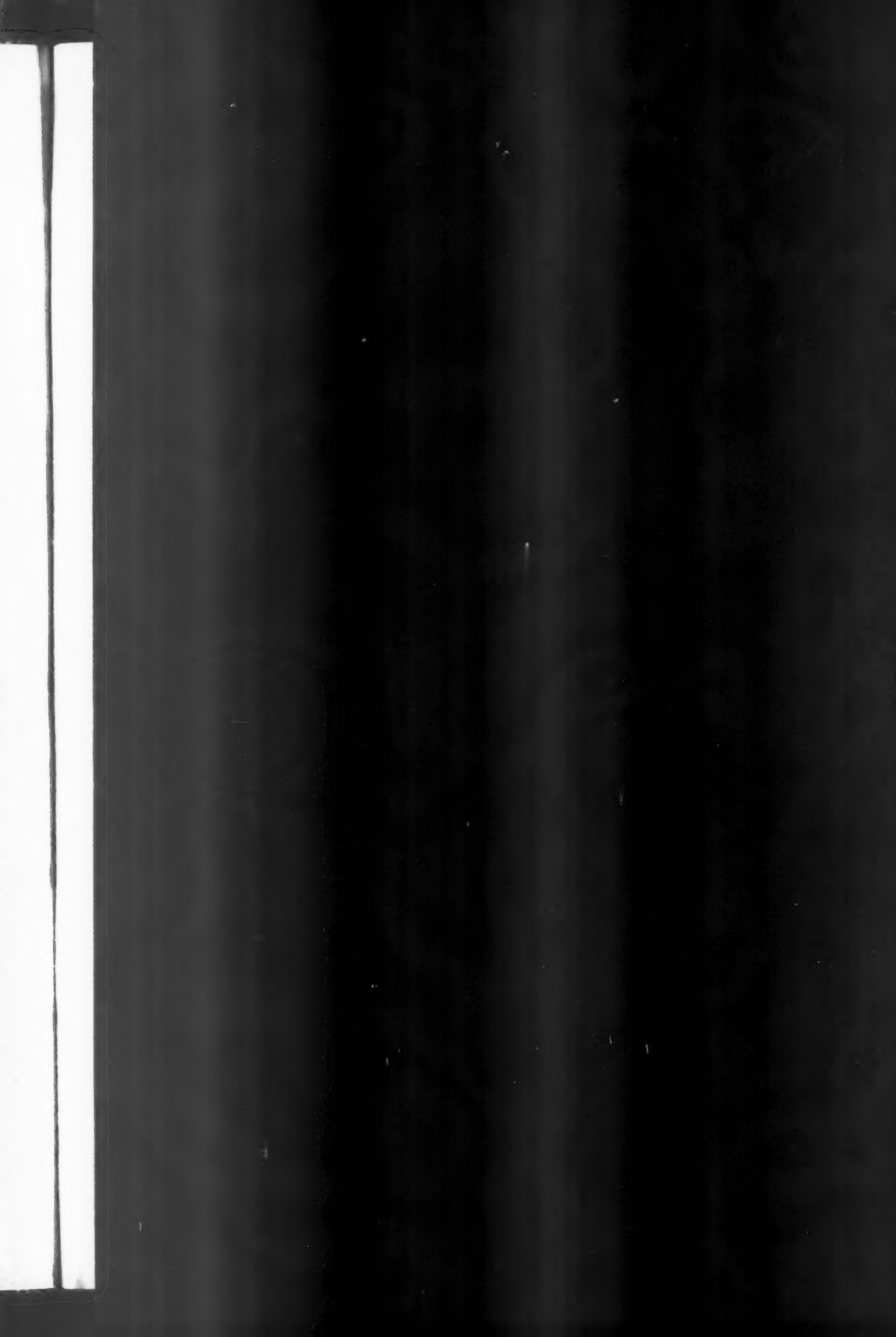

MUNICIPAL ENGINEERING

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RAINFALL AND RUNOFF IN SEWER DESIGN.

By Charles Emerson Gregory, Asso. M. Am. Soc. C. E., Sewer Department, Bronx Borough, New York City.

The following are extracts from a lecture before the engineering school of Union College, Schenectady, N. Y., and a discussion of the subject before the American Society of Civil Engineers, and present in brief the latest advances made in this important subject:

The amount of run-off to be provided for in any drainage problem depends primarily upon the amount and intensity of the rainfall. Most rainfall data available have been obtained with an ordinary cylindrical rain gauge with the evident intention of obtaining a record of the total amount of rainfall for each storm rather than its intensity or rate of fall. In the improvement of rivers and probably most canals the actual intensity might not be of as much importance, but in the design of a combined system of sewers or of a culvert the intensity or rate of rainfall becomes of first importance.

The theoretical determination of runoff from catchment areas depends for its reliability on the rainfall data available and a correct method of using and interpreting such data. The quantity and intensity of rainfall in any locality varies greatly and is much greater at some points than at others, usually diminishing with the distance from the sea or other place of great evaporation, and is considerably influenced by mountain ranges although not always in the same way. In New York state the precipitation is greater in the high altitudes.

In most cases greater weight should be given to reliable local data, even if incomplete, than to more complete data from some other place. In order to work out the laws and their qualifying factors, a careful investigation must be made of the surface conditions and a thorough analysis of what occurs when the rain reaches the earth. I will attempt here to analyze only what occurs when rain falls on urban areas that are provided with sewers to carry away the runoff. Upon reaching the earth the rain water is taken up by the soil or by vegetation, is evaporated, or runs off into the sewers. The proportion of total rainfall that is evaporated and taken up by vegetation varies greatly with the seasons and with the humidity of the atmosphere. That proportion absorbed by the earth varies directly with the percentage of previous areas and their degree of perviousness, and in residential neighborhoods with a large percentage of lawn areas it varies also with the seasons, being much less in winter when the ground is frozen and possibly covered with snow and ice, than in summer when the ground is dry. In well built up areas like the southern end of Manhattan Island, where the paved and roofed area amounts to 90 per cent. of the total, the difference is less marked, as the greater part of the surface is impervious at all times. Even here, however, it has been observed that a storm, occurring when the ground was wet from a previous storm, caused a slightly greater total discharge than one of the same intensity when the ground is dry.

The number, size and manner of making connections with the sewers from the roofs, yards and streets must also influence the rate of runoff, insofar as they influence the time it takes the water to reach the sewer. For instance, it takes water from a street nearly twice as long to reach the sewer through catch basins 1,000 feet apart as when they are separated by 500 feet.

It has been observed that the water, which falls on a more or less irregular surface, does not begin to flow off immediately, but accumulates until the depressions are filled and the primary absorption and evaporation have ceased. It then begins to run off slowly in a film of gradually increasing thickness until it reaches some channel in which it flows more rapidly as it is fed from all sides, and eventually reaches the sewer or drain. Several minutes elapse in the

hardest downpour before the water appears in the sewers in a considerable amount. This time has been observed to vary from five to fifteen minutes, and for well built up areas is from eight to ten minutes.

Most empirical formulas have been deduced presumably to give the relation of the runoff to a rainfall of an inch an hour. If these formulae were to be accepted as accurate and complete and applicable to all conditions and places the problem would be very simple. At the present time, however, we are confronted with the fact that many important sewer systems in New York city and many other places, based on dimensions obtained from the best of the inch-an-hour formulas, have been proved inadequate, and for 1904 alone it cost the city of New York about $3,000,000 to rebuild inadequate sewers. A large majority of engineers favor the use of a formula containing terms representing the area of the watershed, its average slope, with a co-efficient determined by the nature of the surface of the water shed, with many other factors to be considered, such as shape of watershed, frequency and form of inlets, etc.

The rainfall co-efficient seems to be most irrational. It is supposed to represent the rainfall to be provided for and ranges in value from one to three inches per hour. The same rainfall is applied to all sized catchment areas, notwithstanding the well-known fact that the intensity of rainfall varies as a function of the time or duration, through a very wide range. A rational relation between rainfall data and runoff may be shown without assuming a constant rainfall for all conditions and sizes, but by showing first what the probable rate of rainfall for each dissimilar watershed will be, then applying the proper percentage of runoff.

Of this class of formulae, that of R. E. McMath, sometimes with slight modifications, seems to be most generally accepted, and is as follows:

$$Q = C\,R\,A^{0.8}\,S^{0.2} \quad \text{or} \quad Q = C\,R\,A\sqrt[5]{\frac{S}{A}}$$

in which Q is cu. ft. sec. discharge, C is co-efficient of surface conditions, R is co-efficient of rainfall in inches per hour, A is area in acres and S is feet fall per thousand in average slope of the watershed. A detailed description of how it was deduced can be found in the Transactions of Am. Soc. C. E. for April, 1887. In deriving it Mr. McMath proceeded as follows: Each existing trunk sewer and branch sewer, with its capacity, calculated by Kutter's formula, the number of acres tributary, the average slope of flow lines, and a brief description of the surface conditions, were tabulated in their respective columns. Next a careful investigation of the adequacy of each sewer was made and the capacities in cu. ft. per sec. were plotted as ordinates, and the areas tributary as abscissas, then all inadequate ones were circled. A curve was then drawn, including all inadequate circled points, and its equation was found to agree with the formula as above stated, when S is 15, C is 0.7 and R is 2.75. Below this line was a sort of neutral zone where part of the points were circled and part were adequate, due to flat slopes or undeveloped areas, etc. It was found that in most cases, by applying the correct values for the slope and surface co-efficient, the formula gave approximately correct results. This formula has been repeatedly both verified and proved inaccurate by different investigators, and as far as the writer knows is generally considered as empirical.

In 1888 a most complete set of experiments was made in New York city by Mr. Rudolph Hering, and is briefly described as follows: A typical, built up and paved section in the lower part of New York city was selected. A self-registering gauge was erected to record the flow from an area of 221 acres. The interior of the sewer was carefully examined and found to be regular and suitable for the safe application of a slope formula, and a value for the co-efficient of roughness was determined. A survey of the watershed was made and the slope was found to be regular and the average grade was 7 feet in 1,000, and the extremes 10.2 and 3.4 per 1,000. The average length of the sewers from the periphery of the district to the gauge was 2,886 feet and the maximum distance about 4,800 feet. The total area of the district is made up of 96.64 acres of roof area, or 43.5 per cent., 103.32 acres of paved area, or 46.5 per cent., and 21.76 acres of grass area, or about 10 per cent. The population was estimated at 37,700 persons. Rain gauges were placed on roofs in various parts of the district and were read after each storm and compared with the self-registering gauge in Central Park, from which the various rates of fall during each storm were taken. The results from the rain gauges were then plotted on cross-section paper, with time in hours and minutes of the day as abscissas and the recorded intensity as ordinates. On this same sheet was plotted in blue the rate of runoff in cu. ft. sec. as ordinates and to agree with recorded times of day as abscissas.

The accompanying table is a record of

TABLE FOR COMPARISON OF RAINFALL AND DISCHARGE FROM SEWER.

Extracted from Report on the Sewerage System of New York City made by Rudolph Hering, May 31, 1889. Being based on data collected by the author during his examination of the Sixth Avenue sewer, whose drainage area is 221 acres.

Number	Date	Present and Previous Temperature Mean, degrees		Present and Previous Humidity Mean, degrees		Rain Data										Flow Data		
						Total Fall Inches	Durat'n Hrs.	Durat'n Min.	Total Rainfall Cu. Ft. Per Acre	Maximum Fall In.	Duration Min.	Rate per Hour Inches	Cu. Ft. per Sec. per Acre	Discharge of Rain in Cu. Ft. per Acre	Proportion of Rainfall Reaching Sewer	Cu. Ft. per Sec. for Maxi'm Flow Total	Cu. Ft. per Sec. for Maxi'm Flow Per A.	Proportion Maximum Rainfall Reaching Sewer
1	Dec. 15, 1887	40.	40.6	70.	60-61	0.692	9	00	2511.96	.031	10	0.186	0.188	1500.0	0.597	19.732	0.089	.473
2	Dec. 28, 1887	38.3	30.6	96.	79.	1.170	10	45	4247.10	.149	4	2.235	2.253	2892.0	0.681	64.296	0.290	.129
3	*Jan. 25, 1888	17.19	16.13	55-69	55-70-52	0.830	9	30	3012 90	.097	10	0.582	0.587	648.0	0.212	12.638	0.057	.097
4	Feb. 7, 1888	32.	27.6-40.3	100.	93-88	0.250	5	40	907.50	.021	3	0.420	0.423	324.0	0.357	10.864	0.049	.116
5	Feb. 25, 1888	39.3	37.3-35	100.	91-94	1.650	10	30	5989.50	.094	10	0.564	0.565	3312.0	0.553	61.635	0.278	.492
6	Mar. 3, 1888	31.	30-35.6	100.	93-87	0.030	1	20	108.90	.024	10	0.144	0.145	4.2	0.039	0.665	0.003	.021
7	†Mar. 11, 1888	37.16	35.6-31.3	93-100	88-76	2.090	27	05	7586.70	....	..	....	....	.....	....	.....	....	....
8	Mar. 21, 1888	45.3	44.6-33-22.3	97.	97-87-100	0.744	16	50	2700.72	.100	10	0.600	0.605	2760.0	1.022	35.474	0.160	.264
9	Mar. 27, 1888	38.6	33.3	100.	97.	0.190	2	20	689.70	.044	10	0.264	0.266	267.6	0.388	18.624	0.084	.314
10	April 5, 1888	50.	44.6-37.6	100.	75-78	1.560	15	00	5662.80	.070	10	0.420	0.423	3099.0	0.547	79.594	0.359	.848
11	April 14, 1888	43.	37 3	86.	74.	0.110	6	50	399.30	.019	5	0.228	0.230	276.0	0.691	19.067	0.086	.374
12	May 11, 1888	63.6	66.3-62.3	100.	100-95	1.694	20	35	6149.22	.128	10	0.768	0.774	3894.0	0.633	102.430	0.462	.597
13	‡May 14, 1888	56.	60.3-63	94.	90-98	0.680	22	45	2468.40	.049	5	0.588	0.593	1419.0	0.575	60.305	0.272	.458
14	May 18, 1888	53.3	50.3-49	89.	64-77	0.537	13	25	1949.31	.098	4	1.470	1.482	1272.0	0.653	121.275	0.547	.368
15	‡May 24, 1888	58.3	56.3 55.6 58.3	91.	87-75-67	0.371	13	00	1346.73	.029	10	0.174	0.175	864.0	0.642	25.275	0.114	.651
16	May 26, 1888	57.	60.3-58.3	95.	92-91	0.226	4	00	820.38	.026	10	0.156	0.157	492.0	0.600	14.633	0.066	.420
17	June 15, 1888	75.	70.3-64	95.	100.	0.301	2	00	1092.63	.076	8	0.570	0.575	450.0	0.412	41.460	0.187	.325
18	§June 26, 1888	76.3	81.	92.	81.	0.953 0.456	1 0	05 10	3459.39 1655.28	.583	13	2.691	2.711	1692.0 684.0	0.489 0.413	225.860	1.022	.377
19	¶June 28, 1888	59.	70-76	100.	80.	1.768	27	23	6417.84	.118	4	1.770	1.784	3678.0	0.574	180.915	0.816	.457
20	July 9, 1888	65.3	70.6-78.6	98.5	72-74	0.454	21	45	1648.02	.019	10	0.114	0.115	600.0	0.364	9.977	0.045	.391
21	July 19, 1888	70.3	68.3-68.3	86.	71-74	0.650	24	20	2359.05	.394	10	2.364	2.384	878.5	0.372	147.659	0.666	.279
22	July 27, 1888	69.3	74.3-72.3	83.	71-58	0.198	7	30	718.74	.018	10	0.108	0.109	240.0	0.334	5.321	0.024	.220
23	**Aug. 4, 1888	79.6	74.6-71.3	95.	71-69	1.844	4	00	6693.72	.590	10	3.540	3.569	5157.0	0.770	256.800	1.162	.326
24	Aug. 12, 1888	70.	71-70	78.	66-68	0.420	3	45	1524.60	.079	10	0.474	0.478	540.0	0.354	22.836	0.103	.216
25	Aug. 21, 1888	67.3	73.3-73.3	89.	69-65	3.750	20	00	13612.05	.396	10	2.376	2.396	9600.0	0.705	226.750	1.026	.428
26	Sept. 11, 1888	66.3	68.6-69.6	89.	72-86	1.182	17	10	4290.66	.200	10	1.200	1.210	981.0	0.229	138.791	0.626	.517
27	Sept. 13, 1888	65.	69.6	83.	76.	0.873	2	25	3168.99	.299	7	2.563	2.583	1284.0	0.405	146.550	0.661	.256
28	††Sept. 19, 1888	71.3	68.3-62-58	88.	84-73-65	1.424	22	40	5169.12	.410	16	1.537	1.550	.....	....	157.414	0.710	.458
29	Oct. 6, 1888	59.	47-46	82.	55-69	2.035	22	10	7387.05	.145	15	0.580	0.584	4620.0	0.625	89.347	0.403	.690
30	Oct. 12, 1888	50.6	42.6-44	70.	51-55	0.204	6	30	740.52	.024	10	0.144	0.144	555.6	0.750	17.293	0.078	.542
31	Oct. 16, 1888	53-50.6	46.3	71-68	59.	0.327	25	15	1187.01	.090	5	1.080	1.089	1131.6	0.953	69.839	0.315	.289
32	Oct. 19, 1888	48.3	50.6-46	67.	57.	0.395	20	35	1433.85	.088	10	0.528	0.528	903.6	0.630	58.753	0.265	.502
33	Oct. 27, 1888	55.	51.6-50	100.	93.	0.562	18	25	2040.06	.048	10	0.288	0.288	1896.0	0.929	24.166	0.109	.378
34	Oct. 28, 1888	52.6	50-55	100.	100.	0.132	2	05	479.16	.020	10	0.120	0.120	276.0	0.576	10.420	0.047	.392
35	Nov. 8, 1888	49-62.3-62.3	53.	100-100	74.	1.832	49	00	6661.05	.187	5	2.244	2.263	6247.2	0.938	199.973	0.902	.399
36	Nov. 15, 1888	52.6	43.6-49.6	97.	87-91	1.222	14	20	4438.86	.068	9	0.453	0.457	3680.0	0.830	76.263	0.344	.753
37	Nov. 19, 1888	50.6	36.6-37.3	90.	72-79	0.496	14	10	1800.48	.037	10	0.222	0.222	1500.0	0.833	31.926	0.144	.649
38	‡‡Nov. 25, 1888	30.3-37.3	33.6	100-95	76-89	0.770	40	05	2795.10	.010	10	0.060	0.060	2683.2	0.960	12.415	0.056	.983
39	Dec. 9, 1888	39.3	35.3-41.3	100.	74-77	0.243	9	00	882.09	.015	10	0.090	0.090	759.0	0.860	9.311	0.042	.467
40	Dec. 11, 1888	39.	39.3-36.6	90.	94-91	0.302	4	33	1096.26	.020	10	0.120	0.120	1008.0	0.919	16.849	0.076	.633
41	Dec. 17, 1888	52.	27.6-41.6	100.	79-75	2.290	24	05	8312.70	.108	5	1.296	1.307	5756.0	0.692	107.746	0.486	.372
42	Dec. 27, 1888	46.	42.6-46.6	81.	66-83	0.405	18	22	1470.15	.050	4	0.750	0.756	1339.2	0.911	23.057	0.104	.138

*1¼ inches of snow. †Severe snow storm (blizzard). ‡Two Storms. §Very heavy thunder showers. ¶Local storm, the fall at our gauges much greater than at Prof. Draper's. **Storm of greatest intensity during year. ††Sewer record not complete, float caught. ‡‡Snow and hail 1½ inches on 25th.

the complete series of observations of two typical storms. The wide range and sudden changes in intensity are in this way clearly shown, together with the corresponding flow in the sewer.

The sewer where the gauge was located had a capacity in cu. ft. a second equal to about 90 per cent. of the acres tributary and at one time during the year was just filled and three times ran under a slight head. The rates of rainfall and the percentage running off show a wide range of variation, and were it not that some of the variable factors tend to equalize each other it would seem a hopeless task to deduce a general law to govern these variations. It must be remembered, however, that only the maximum flow from the severest storms is to be considered and the apparent contradictions of the lesser ones may be thrown out.

Mr. Hering concludes by recommending a formula like McMath's in form, but changing the exponents to 0.83 for A and 0.27 for S, and recommending for values of C R, for metropolitan districts 1.64, for suburban districts 1.02. It does not seem that the slight modification of the roots is of enough importance to change from the original McMath's form, and Mr. Hering in subsequent reports recommended the use of the McMath's formula.

Many of the watersheds met with in practice are long, narrow valleys, and it becomes evident that one must take into account the shape of the watershed and the time it takes the rain water to run off. In order intelligently to take into account the influence of shape and time a study was made of the records of Mr. Hering's report and records of storms in Rochester, made by Mr. E. Kuichling, and such other data as could be obtained.

In a recent publication of the American Society of Civil Engineers there appeared some very complete and extensive rainfall data, giving the rates of precipitation and duration of all storms of note for twenty-six years near the city of Boston, Mass. These data were compared with reliable data from other places in the eastern part of the United States, as shown in vol. xvi of the proceedings of the society and are valuable additions to our knowledge on this subject. The writer looked for a relation between these data and a reliable formula for runoff without much success until it occurred to him that the intensity of rainfall and consequently the runoff was always a function of the duration of time of the storm. The ordinary curve of maximum rainfall devised by Prof. Talbot, in which the intensity of rainfall is plotted as ordinate and duration in minutes as abscissas and whose equation is

$$i = \frac{105}{t + 15}$$

when i is intensity in inches per hour, and t is duration in minutes, seemed to best express this relation. This curve inclosed all but a very few storms on record in the eastern part of the United States.

By using this or a similar expression for intensity, it is evident that a more rational and general formula than those in general use may be deduced to show the relation of rainfall to runoff; one that would not only simplify this problem of the relation of runoff to rainfall, but also take into account the shape of the watershed and definitely fix the relation of the variable factors that enter into the design of a drainage system without limiting the range of values that it might, in the judgment of any engineer, seem desirable to assign to any factor, and possibly also serve as a basis for harmonizing, somewhat, the conflicting data.

First assume that, for all watersheds of equal area and of similar shape, character and slope, there should be a fairly constant ratio between rainfall and runoff for storms of equal duration and intensity. In practice, however, all watersheds and all storms are different. Therefore, each different storm and watershed must be reduced to a common basis of comparison. The maximum flow from all watersheds, except those of unusual shape, obviously, is at the time when all parts of the area are first contributing their average maximum to the outlet at the same time. For any shorter period only part of the area would be contributing, and, for a longer period, the intensity would be less. The qualifying factor, in any watershed, which can not be expressed by a direct co-efficient, is the time it takes the rain, falling on the roofs and streets in the most distant part of the watershed, to reach the point under consideration.

The qualifying factors in the storm are its duration and intensity. All storms, however, may be reduced to a basis of comparison on a particular watershed by comparing the greatest average intensity for the time the water takes to travel to the point in question, rather than the maximum intensity for a shorter time, or the average for the entire storm. Storms compared on this basis show a remarkably constant relation to the maximum runoff, while if compared in other ways, they show great variation. Unfortunately, as yet, but few

data which are in proper form to make this comparison have been available, and it has been necessary to rely to a great extent on data taken from a report by Rudolph Hering, M. Am. Soc. C. E., on gaugings taken in 1888 in the Sixth avenue sewer, in New York city.

The relation of intensity of storms to their duration is most simply expressed for our present purpose by Prof. Talbot's "ordinary" form of curve, stated above. To find the proper intensity of any shape watershed, substitute t, the ratio of the greatest length of the watershed, l, to the average velocity in feet per minute, v; then, calling inches per hour equivalent to cubic feet per second per acre, Q equals A C i, in which Q is cubic feet per second, A is acres and C is the co-efficient of the relation of runoff to rainfall, and will vary with the nature of the surface and the drainage system; then, for i, substitute its value and allow, say, ten minutes for the water to reach the sewer from the roofs and streets, and the result is

$$Q = A\,C\frac{105}{\frac{l}{v}+15+10} \quad . \quad . \quad . \quad (1)$$

or a general form

$$Q = A\,C\frac{B}{\frac{l}{v}+D+E}$$

To make the formula general, express v in terms of A and S, S being the average slope of the watershed, in feet per thousand. To do this it is necessary to substitute in the standard formulas for velocity,

$$v = c\sqrt{R\,S}, \text{ and } Q = a\,v$$

in which c is a variable co-efficient; R is the hydraulic mean radius; S is the sine of the slope of the water surface; v is the velocity, in feet per second; a is the area of the sewer section, and Q is the discharge, in cubic feet per second. Giving to c an average value of 120, expressing S in feet per thousand, substituting the values of a and d in terms of R, and assuming an average value of R, whence d equals 9 R, we have

$$v = 1.4\sqrt[5]{Q\,S^2}.$$

Then, as A is an average value for Q, it is sufficiently accurate to substitute it for Q, and, expressing v in cubic feet per minute, or sixty times the value above,

$$Q = A\,C\frac{105}{\left\{\frac{l}{84\sqrt[5]{A\,S^2}}\right\}+25} \quad . \quad (2)$$

as the general form for the relation of runoff to rainfall, and this can be compared directly with any rainfall data which may be desirable by simply comparing it with the Talbot intensity curve.

This formula gives for average-shaped watersheds values somewhat similar to McMath's, when 0.80 is used for C and 2.75 for r, but varies more nearly with the slope and gives smaller results for very long narrow watersheds and larger ones for those which are fan-shaped; the difference being due to the difference in time required for the water to reach the outlet over the different distances of each watershed.

If great accuracy is desired, the value of the first term in the denominator may be tested, after the sizes and velocities have been worked out, by taking the actual velocities and using formula 1, and, if desirable, the time allowed for the rain to reach the sewers, or any of the factors may be changed.

Any formula of this form gives too great results for small areas, as any intensity greater than that which agrees with the time it takes the water to reach the sewers is misleading, and this form of equation gives no opportunity to allow for this in the formula.

Two examples of the application of the above methods will be briefly noted. A report was made on the probable effect of a storm having a duration of twenty minutes and an intensity of three inches per hour, on a watershed of 70 acres and a slope varying from 5 to 40 feet in one thousand. It was ascertained that the watershed consisted of about 50 per cent. impervious area and a value of 0.33 was given to the co-efficient, C. The sewers already being built, the time it would take for the water to travel from the remote part of the watershed to the outlet, was calculated from the actual velocities. This time was applied to formula (1), and from the resulting quantity was established the hydraulic gradient for the existing sewers. This showed that the outlet sewer was much too small and that the theoretical head of the water would rise about nine feet above the street surface. It was also reported that this maximum flow would occur about seventeen minutes after the beginning of the intense rainfall and would probably not last over five minutes. Within a month after this report a similar storm oc-

curred and an inspector of the sewer bureau observed that the predicted conditions occurred at the times and in the manner indicated. Another watershed of 62 acres was similarly reported on and the height to which the water actually rose agreed with the report within one foot.

In any formula in which the slope is a variable factor it is obviously necessary to determine a correct value for the average slope. This is not as easy as it would at first seem, unless the entire watershed has a fairly uniform slope. When the slope is not uniform the proper average can not always be determined by taking the total difference in elevation and dividing by the total distance, nor can it be found by averaging the greatest slope with the least slope. For example, a certain watershed is two miles long with a total fall of 50 feet, or a fall of 5 feet in 1,000, but 43 feet of the fall occurs in the first 1,500 feet and 30 feet of the 43 in 500 feet. The average velocity for 5 in 1,000 is about 8 feet a second. And water would therefore travel 10,500 feet in 21 minutes, while the average velocity for 0.8 in 1,000, the actual slope, is about 4 feet a second, and would require 37 minutes to travel the 9,000 feet before reaching the steep grade; add to this about 3 minutes for the remaining 1,500 feet and it shows 100 per cent. difference. The average can be very closely determined by dividing the watershed into districts or lengths, each having a uniform slope for a known distance and giving each slope weight in proportion to the square of its length. Apply this to the above example, making only two subdivisions, and it will be found to have an average slope of 1.5 in 1,000 and take about 43 minutes to travel 10,500 feet, a very close approximation to the actual.

The very important qualifying factor that may be expressed by a constant in any watershed is the character of the surface. This is expressed in most formulas by the letter C and has a wide range of values. The value for C in the above formula has been determined from the available data in the following manner: The severer storms recorded by Mr. Hering when averaged for the time of the watershed, 28 minutes, give a very uniform value for C, differing very little either way from 0.50. Also nine severe storms that were gauged by Mr. E. Kuichling in Rochester, N. Y., on a watershed of 128.7 acres, having about 30 per cent. of impervious area and its time of maximum run-off 29 minutes were compared and it was found tahat the maximum run-off averaged about 0.26 of the greatest intensity of rainfall for 29 minutes. The greatest range of values was from 0.21 to 0.38, but the majority of them differed but one or two points from the average. Mr. Kuichling's experiments were not made with as delicate or reliable instruments as those in New York, and therefore one could not expect as great uniformity in the results.

If a watershed having ninety per cent. of impervious surface has a run-off of 0.50, and one of thirty per cent. impervious area has a run-off of 0.26, and we let x be the coefficient for pervious or grass area and y the coefficient for impervious area, then 0.1x plus 0.9y equals 0.50 and 0.7x plus 0.3y equals 0.26 and x equals 0.14 and y equals 0.54, the limiting values for C. Then for any value for C take the sum of the product of the percentage of impervious area by 0.54 and the product of the pervious area by 0.14. These are average maximum values and are not absolute, and further observation may change them considerably.

It must also be borne in mind that for pervious areas a greater total run-off might occur in March from a rain of low intensity when the surface is rendered impervious by snow and ice. In this case C would be determined by multiplying its maximum value, 0.54, by the average percentage the intensity of the storms of March is of the maximum storms. This is roughly about twenty-five per cent, except for very large areas, and gives a value equivalent to C at 0.135 or about the same as C for pervious areas during the months of maximum precipitation.

A further complication occurs when we have an area made up of two very different classes with respect to the value of C. A greater rate of run-off may result if the impervious area lies near to the point in question than if the impervious area lay at the most distant point, and the opposite if the positions are reversed. This may be explained as follows: The impervious area may produce a maximum flow before the entire pervious area is contributing; and, therefore, from a storm of greater intensity. On the other hand, the maximum would occur only when the most remote impervious area was contributing, and, therefore, at such a time would render the intensity less.

The following conclusions may be drawn from the preceding discussion:

1st. That in all rain-storms in the eastern part of the United States, the intensity or rate of rainfall is a function of their duration or time.

2d. That the rate of run-off from similar storms and from similar watersheds bears a constant direct relation to the rate of rainfall.

3d. That watersheds which differ in size, slope, shape, or kind of drainage system, will consequently differ in the time required for all parts to be contributing to the outlet at the same time, and, consequently, will have a different rate of rainfall to agree with the relation of intensity to time.

4th. That the formulas in current use, to show relation of run-off to rainfall, that give a constant rainfall coefficient, are misleading and irrational, if not incorrect, and give the designer no true knowledge of the kind of storm he is providing for, or of the probable effect of a given storm.

5th. That rates of run-off in all severe storms on areas of similar character have a constant, direct relation to the average rate of rainfall for the time of the watershed, rather than to the maximum rate, or to the average of the entire storm.

6th. That the percentage of impervious area probably directly affects the rate of run-off, but the relation for long time watersheds may vary slightly as a function of the time.

7th. That almost every term in any run-off formula may vary for different localities, and, therefore, the designer should clearly understand their relation and importance.

8th. That formulas (1) and (2) with their demonstrations show these relations without limiting in any way changes to agree with any locality or condition.

THE STRENGTH OF REINFORCED CONCRETE.

By T. L. Condron, Chicago, Ill.

The following extracts from a paper before the Western Society of Engineers and from the discussion of the same give a resume of conclusions which may be drawn from the results of tests which have been made upon reinforced concrete beams:

During the past two years a large number of scientifically conducted tests of reinforced concrete beams have been made, which are briefly summarized as follows:

TABLE I.

Purdue University	14 Beams	8″ x 8″ on 6′ 8″ Spans.
Massachusetts Institute of Technology	26 Beams	8″ x 12″ on 11′ 0″ Spans.
Rose Polytechnic Institute	18 Beams	12″ x 5″ to 12″ x 21″ on 10′ to 18′ Spans.
University of Illinois	18 Beams	12″ x 13½″ on 14′ Spans.
University of Pennsylvania	35 Beams	6″ x 6″ on 5′ Spans.
University of Wisconsin	23 Beams	8″ x 8″ on 5′ and 8′ Spans.
Chicago, Milwaukee & St. Paul Ry	14 Beams	12″ x 8¼″ to 12″ x 20″ on 6′ to 10′ Spans.
Boston Transit Commission	54 Beams	8″ x 8″ on 5′ 0″ Span.
Total	202	

In order to make a comparative study of the above tests the writer has computed the actual ultimate bending moment, M, developed for each test due to the weight of the beam and the breaking load: also the percentage of reinforcing for each beam. This latter has been taken as P, equals 100 multiplied by area of bars, divided by bd. Fig. 1:

As will be noticed no account has been taken of the depth below the plane of the reinforcing; the effective depth being considered the distance "d." As beams vary in strength directly as the breadth, b, and the square of the depth, the basis of this study has been to plot the results of all these tests so as that the ordinates would represent the values of M, divided by bd square, while the abscissas represent the values of P.

The diagrams here presented, Figs. 2 to 12 inclusive, are the graphical representations of the results of all of these tests, reduced to the above uniform basis of comparison.

Fig. 2 shows the results of 15 tests with plain reinforcing at Purdue University, as reported by Prof. W. K. Hatt to the American Society for Testing Materials in 1902. It will be seen that all of the tests of rock concrete fall upon, or

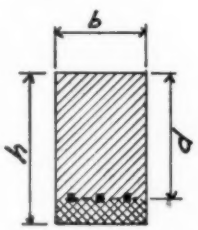


FIG. 1.

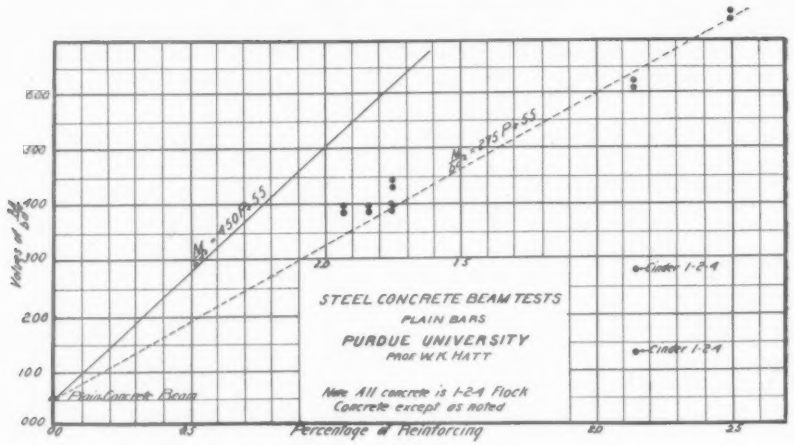


FIG. 2.

very close to, the dotted line, the equation of which is

$$\frac{M}{b\,d^2} = 275\,P + 55.$$

Fig. 3 shows the results reported by Prof. G. Lanza, of the Massachusetts Institute of Technology. These tests were made with plain steel bars, and Ransome twisted bars. These results are very erratic, notwithstanding the fact that all of the beams tested were of the same size and span.

Fig. 4 shows the results reported by Prof. M. A. Howe, of the Rose Polytechnic Institute. His tests were made on beams, all 12 inches wide with depths of 5, 7, 9 1-2, 10, 14 1-2, 18, 19 and 21 inches. All of the beams were reinforced with corrugated bars and about half of the number had 0.7 per cent. reinforcing, or the percentage called for by Johnson's formula for average rock concrete. The balance had 0.6 per cent. reinforcing. On this diagram is shown the theoretical strength called for by Johnson's formula. The line passing through this point represents the equation M divided by bd square equals 450 P plus 55. This line

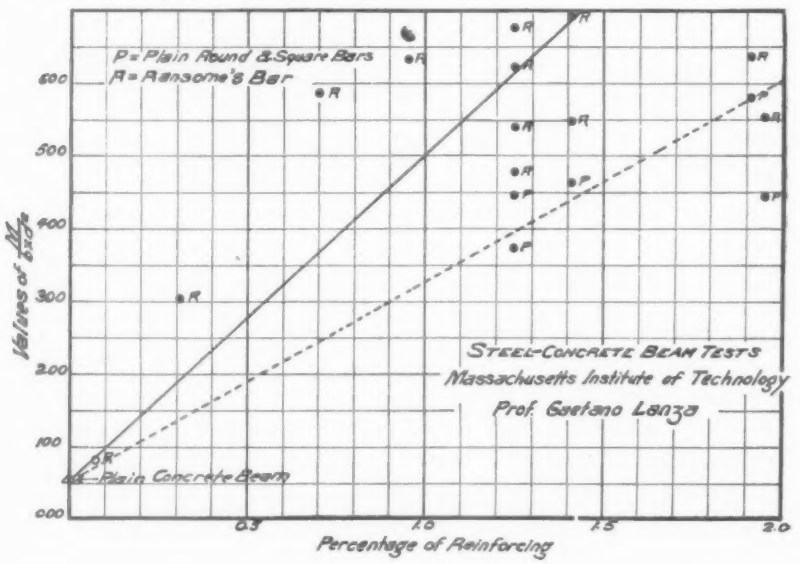


FIG. 3.

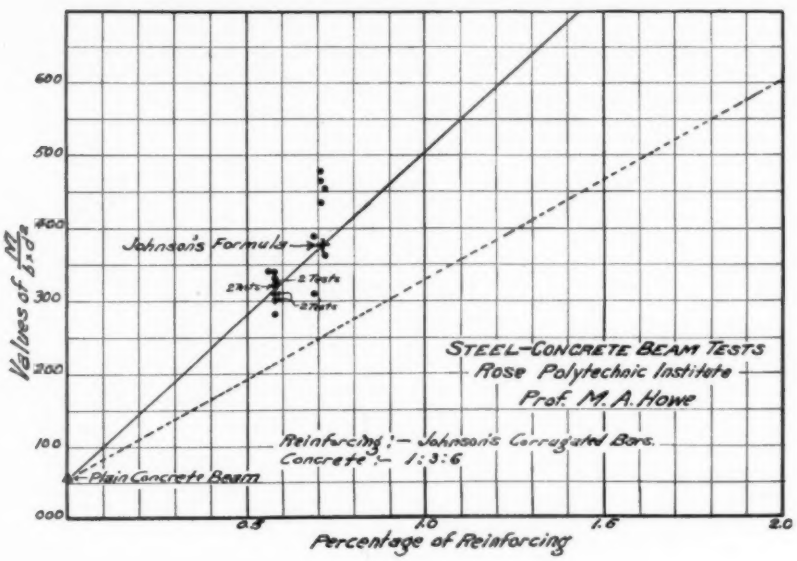


FIG. 4.

and the dotted line of the equation M divided by bd square equals 275 P plus 55 have been repeated on all of the diagrams as reference lines.

Fig. 5 shows the results reported by Prof. A. N. Talbot, of the University of Illinois. His beams were all of the same size, namely 12 inches wide by 13 1-2 inches deep, or 12 inches deep to the plane of the reinforcing, and tested on a 14-foot span. These tests are of especial interest as various percentages of reinforcing and different forms of bars were used. It was the study of these tests that first led the writer to observe that straight lines would pass through the results of tests for each kind of reinforcing and that these lines would intersect in a point representing the strength of a plain concrete beam. The equation M, divided by bd square equals mP plus n, becomes for a plain beam M, divided by

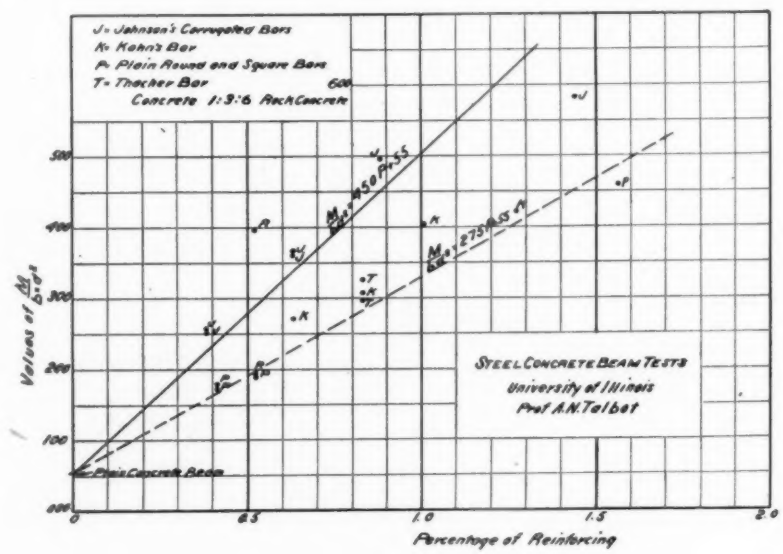


FIG. 5.

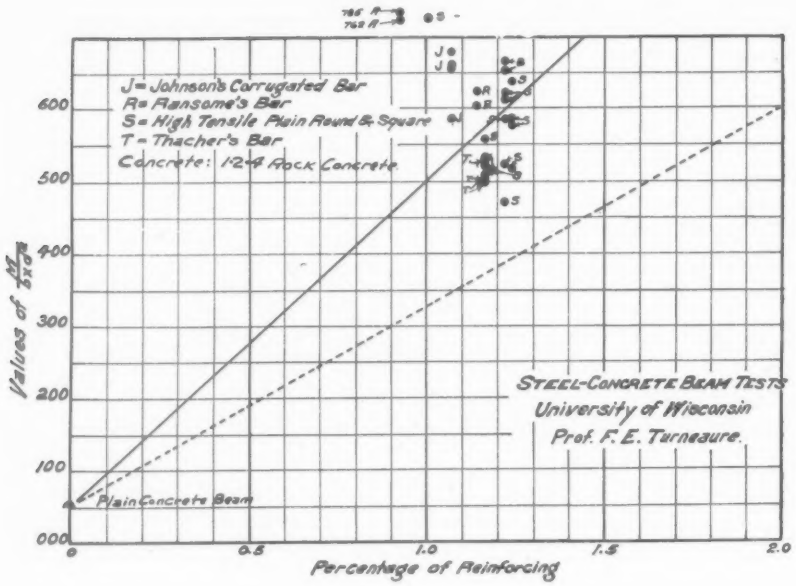


FIG. 6.

bd square equals n, for d becomes h and P equals 0. The writer found the value of n from three tests of plain beams to be approximately 55. The three plain beams were reported by Prof. Lanza, Prof. Talbot and Mr. J. J. Harding, of the C., M. & St. P. Ry.

Fig. 6 shows the results reported by Prof. F. E. Turneaure, of the University of Wisconsin. His tests were made upon small beams, 6 inches by 6 inches and 5 foot spans. The percentage of reinforcing was not varied for each type of bar used. Two unusual features of these tests were that the beams were kept under water until tested and that the plain bars used were of special steel, having an elastic limit of

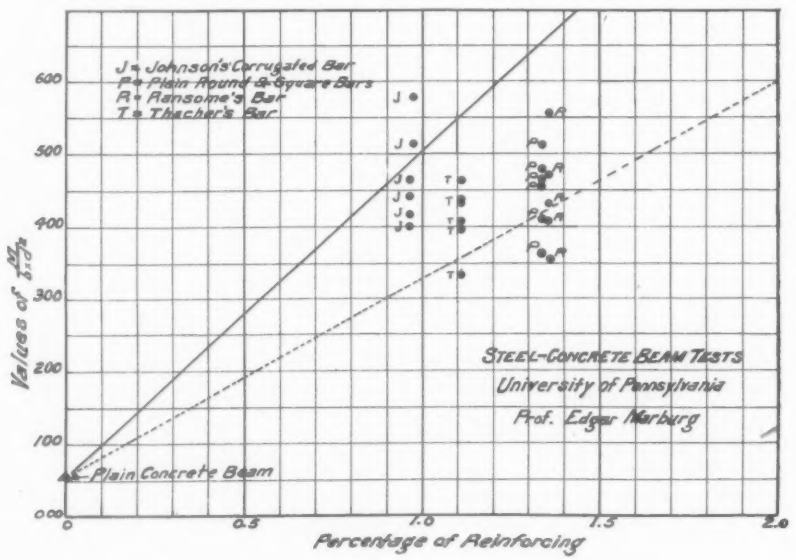


FIG. 7.

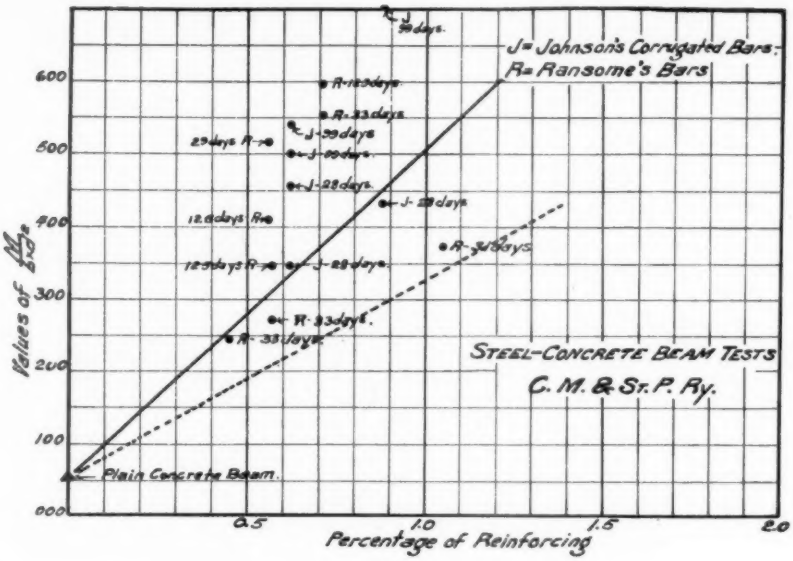


FIG. 8.

75,000 pounds per square inch, or about double that of ordinary structural steel bars. Also the compressive strength of his concrete was unusually great, testing above 4,000 pounds per square inch. It is interesting to note from table III, that while the special plain bars had an elastic strength 27 per cent. greater than the corrugated bars, 3 per cent. greater than the twisted bars and 67 per cent. greater than Thacher bars, they did not develop as much strength as the two former and but little more than the last named, showing that even for static tests, it is necessary to have some mechanical bond between the concrete and the steel

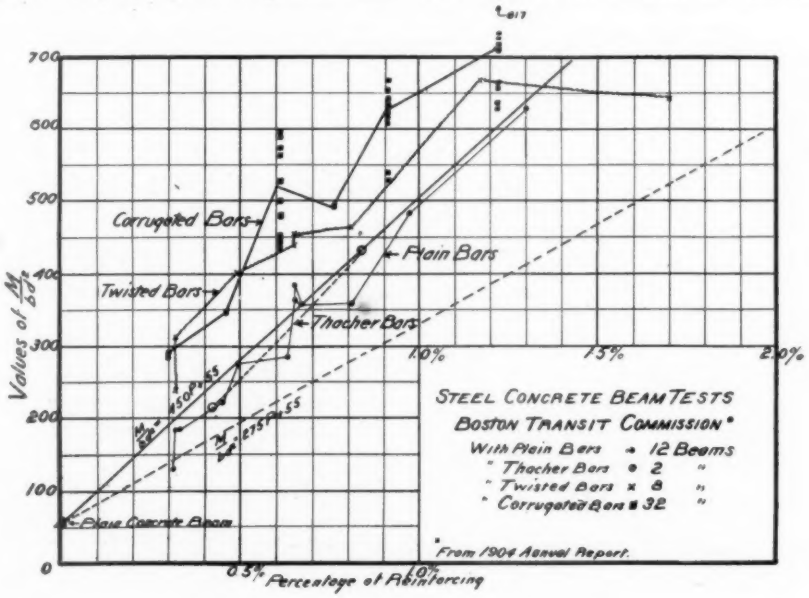


FIG. 9.

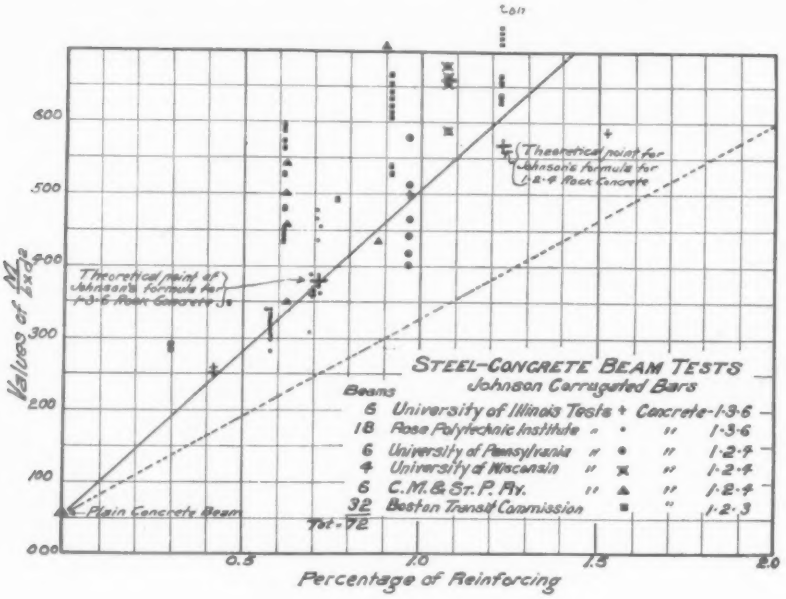


FIG. 10.

in order to take advantage of high elastic steel.

Fig. 7 shows the results reported by Prof. Edgar Marburg, of the University of Pennsylvania. His tests were made on beams of uniform size, 8 inches by 8 inches, and on spans 5 feet by 8 feet.

Fig. 8 shows the results reported by Mr. J. J. Harding, of the tests made by the C., M. & St. P. Ry. These results are quite erratic, but generally owing to superior quality of concrete, higher results were obtained than in most of the other tests referred to above, but they agree

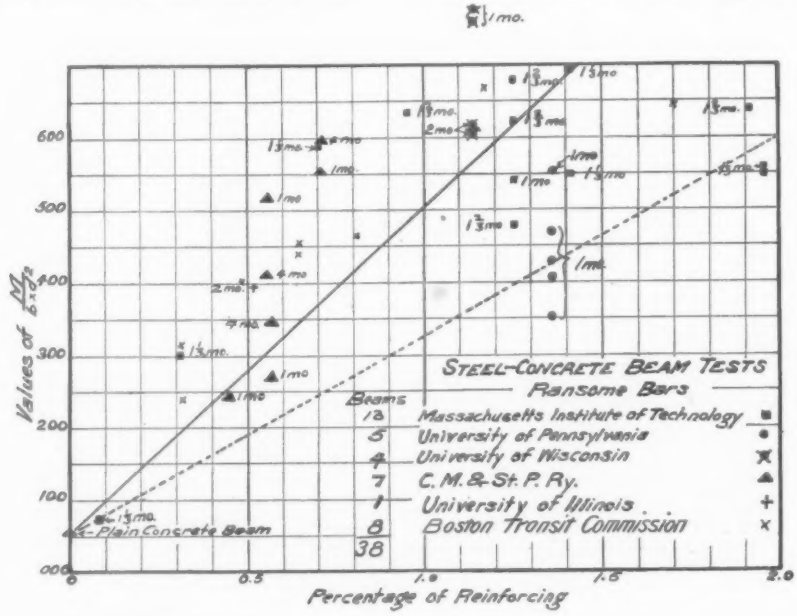


FIG. 11.

very well with the tests of the Boston Transit Commission.

Fig. 9 shows the results of the very extensive series of tests made by the Boston Transit Commission, and described in the 10th annual (1904) report of the commission. As in the tests at the University of Wisconsin and by the C., M. & St. P. Ry. Co. a very strong concrete was used, testing above 4,000 pounds per square inch in compression. On this diagram the results for each kind of reinforcing have been connected by lines to make it easy to follow the same. From table III the elastic limit of the bars are: Plain bars, 53,000 to 45,000 pounds; Thacher bars, 40,760 pounds; corrugated bars, 60,100 pounds; and twisted bars, 67,600 to 69,700 pounds. It would naturally be expected that the strongest beams would be those reinforced with twisted bars, since those bars had the highest elastic limit, but this was not the case.

Fig. 10 shows all the tests reported in which corrugated bars were used. There are 72 such tests. The following is a brief capitulation of these results relative to the straight line formula,

$$M = (450\,P + 55)\,bd^2.$$

80 per cent. are above the formula.
20 per cent. are below the formula.
8 per cent. are more than 10 per cent. below the formula.
The lowest is 22 per cent. below the formula.

Fig. 11 shows all of the tests reported in which twisted bars were used. There are 38 such tests and a similar capitulation with reference to the same straight line formula, is as follows:

60 per cent. are above the formula.
40 per cent. are below the formula.
37 per cent. are more than 10 per cent. below the formula.
29 per cent. are under 20 per cent. below the formula.
The lowest is 52 per cent. below the formula.

Fig. 12 shows all of the tests reported in which plain structural steel bars were used. There are 40 such tests. All but two of these results fall below the straight line equation M equals (450 P plus 55) bd square, but they will be seen to lie reasonably close to the line M equals 275 P plus 55) bd square, which equation is equivalent to 39 per cent. less strength than the former, or the former is 64 per cent. stronger than the latter. The tests

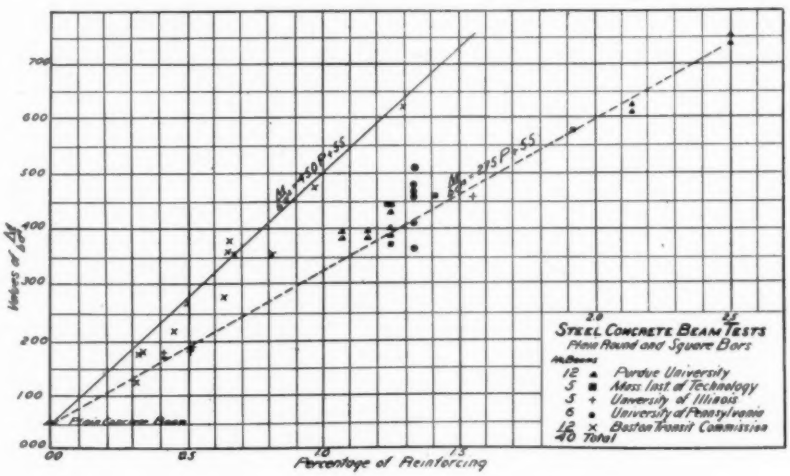

Steel Concrete Beam Tests
Plain Round and Square Bars
No. Beams
12 ▲ Purdue University
5 ■ Mass. Inst. of Technology
5 + University of Illinois
6 ● University of Pennsylvania
12 × Boston Transit Commission
40 Total
Plain Concrete Beam
Percentage of Reinforcing

FIG. 12.

of the Boston Transit Commission are practically 45 per cent. above the other tests on this diagram, owing to the stronger concrete used.

The writer has adopted as a basis of the study of all the beam tests that have come to his attention the straight line equation,

$$\frac{M}{bd^2} = mP + 55.$$

In making comparisons, he has transposed all the known terms to the left side of the equation, thus:

$$\frac{\dfrac{M}{bd^2} - 55}{P} = m.$$

and he has determined the value of m, for each beam tested. These values are given in table II.

The elastic limits of the different kinds of bars are given in table III, from which it will be seen that for plain structural steel bars, the range is from 32,000 to 45,000 pounds, averaging 37,700 pounds. Likewise for corrugated bars, this range is from 55,000 to 65,800, averaging 60,100 pounds, and for twisted bars the range is from 58,000 to 73,000, averaging about 67,000 pounds, as there were more tests reported than below 65,000 pounds.

In table IV is given a comparison by percentages, of the elastic limits reported, and of the average strengths of the beams reinforced with different kinds of bars; the figures being deduced from tables II and III. The ratios in table IV are instructive, for it has generally been considered that under static loads, as in laboratory tests where there is no impact or shock, no special advantage would be shown for "deformed bars" over plain bars of equal strength at the elastic limit. It is evident from the results reported by Prof. Turneaure, that plain bars of high carbon steel, having an elastic limit of 75,000 pounds (or practically double that of ordinary structural steel), do not develop a corresponding increase in the strength of the beam. Tensile stress in the bars not only lengthens them, but also contracts their diameter, breaking the bond between the concrete and the bars, allowing the bars to slip unless other provisions are made to form a bond. This would seem to explain the fact that for all of the "deformed bars" except the twisted, the ratio of increase in the strength of the beams is greater than the ratio of increase in the elastic limit.

CONCLUSIONS.

It would seem that a sufficient number of rectangular beam tests had been made, from which to draw valuable conclusions as to the probable behavior of such beams in practice. From Prof. Turneaure's tests at the University of Wisconsin it is learned that when the tensile stress in the steel reinforcing exceeds 15,000 pounds per square inch, fine hair cracks begin to appear in the concrete. These cracks, if present, are microscopical until the steel is stressed to about 15,000 pounds per square inch or until the stretch is equal to 5 ten-thousandths of its length, or five times more stretch than plain concrete will withstand without complete rupture. Failure, however, does not occur until the stress in the bars has passed the elastic limit.

From the tests it is also learned that reinforced concrete beams have more of the characteristics of steel than of plain concrete beams. They deflect under loads and recover when the loads are removed; and before failure occurs there is ample warning given by the appearance of large cracks in the concrete indicating that the steel is approaching its elastic limit.

From the tests it is also learned that reinforced concrete beams have more of the characteristics of steel than of plain

TABLE II.—**Comparison of the Actual Ultimate Strengths of Beams Tested with the Theoretical Ultimate Strength (1,00) determined for each Beam, by the Formula $\left[\frac{M}{bd^2} - 55\right] \div P = m$

Kind of Bars used / Average Elastic Limits of Bars		Plain 37,700		Spcl Plain 75,000		Thacher 36 900		Twisted 67,000		Corrugated 60 100		Kahn 34 000		Strength of Concrete in Compression
		No.	m	No	m	No.	m	No	m	No.	m	No	m	
University of Illinois	Minima		256				288		*		405		288	
	Averages	5	275.			2	306	1	652.	6	504	4	316	3030
	Maxima													
Mass Institute of Technology	Minima		198						†256					
	Averages	5	283.					13	†445.					Not reported
	Maxima													
Purdue University	Minima		‡261											2575
	Averages	12	‡288											2730
	Maxima													2880
University of Pennsylvania	Minima		225								360			1360
	Averages	6	292			6	242	5	217	6	432			1710
	Maxima						324		283.					2500
Rose Polytechnic Institute	Minima										369			
	Averages									18	477			Not reported
	Maxima													
University of Wisconsin	Minima				342		378		500		531			2500
	Averages			19	445.	4	391	4	558	4	549			3913
	Maxima													4250
Chi., Milwaukee & St Paul Ry.	Minima								301		432			
	Averages							8	567	6	630			Not reported
	Maxima													
Boston Transit Commission	Minima		364.				387		346		477			2840
	Averages	12	441.			2	418.	8	585.	32	8644			3930
	Maxima													4960
Number of Tests and General Averages		40	333.			14	351.	39	494	72	566			

* One test only reported with twisted bars. The result of this test (652) is apparently inconsistent with all of the other tests.
† All tests with more than 2% reinforcing omitted. If 7 tests with over 2% are included, the average becomes 0 8
‡ Two tests of cinder concrete omitted. § Neglecting 12 tests with bars in compression as well as tension.
**Revised once advance publication.

concrete beams. They deflect under loads and recover when the loads are removed; and before failure occurs there is ample warning given by the appearance of large cracks in the concrete indicating that the steel is approaching its elastic limit.

Likewise it is proven that the ultimate strength of such beams is coincident with or a little above the point when the stress in the steel reinforcement passes its elastic limit. If high elastic steel is used it seems necessary to have a positive bond between the steel and the concrete to develop this strength, as the adhesion of concrete to plain steel is not sufficient. (See results of Prof. Turneaure's tests with plain rods of 75,000 pounds elastic strength.)

more than this will not be economical, at the usual costs of materials in this part of the country. Reinforcing of 1.0 per cent. is equivalent to approximately 120 pounds of steel per yard of concrete, or 100 pounds of steel per cubic yard of concrete is equivalent to 0.83 per cent. of reinforcing.

DISCUSSION.

Prof. A. N. Talbot—1. It must not be taken from the statement in the first paragraph of conclusions that the first visible crack appears at some definite point in the stretch of the steel and concrete. The time of appearance may extend over a wide range for the same mix of concrete. For example, in the tests at the University of Illinois, quoted by Mr. Con-

TABLE III.

Elastic limits of reinforcing bars used, in pounds per square inch.

	Plain	Twisted	Corrugated	Thacher
Purdue University	36000	.....	.....	.....
Massachusetts Institute of Technology	Not reported	Not reported	.....	.....
Rose Polytechnic Institute	.....	.....	60000	.....
University of Illinois	32000-35000	.....	55000-60000	32000-35000
University of Wisconsin	75000	73000	59000	45000
University of Pennsylvania	40500	58000	65800	31900
Boston Transit Commission	35000-45000	67600-69700	60100	40760
Chicago, Milwaukee & St. Paul Ry	.....	Not reported	60000	.....

TABLE IV.

Comparison of average elastic limit of bars and relative strength of beams tested.

Kind of Bars	From Table III Elastic Limit of Bars	From Table II Strength of Beams
Plain	38000 = 100%	333 = 100%
Thacher	37000 = 98%	351 = 105%
Special Plain	75000 = 197%	445 = 134%
Twisted	67000 = 176%	490 = 147%
Corrugated	60000 = 158%	566 = 170%

It is also proven that the strength of the beam is a function of the strength of the concrete in the beam. Note that the Boston Transit Commission obtained nearly 50 per cent. higher results with concrete of 4,000 pounds compressive strength than other experimenters obtained with concrete of from 2,000 to 3,000 pounds compressive strength.

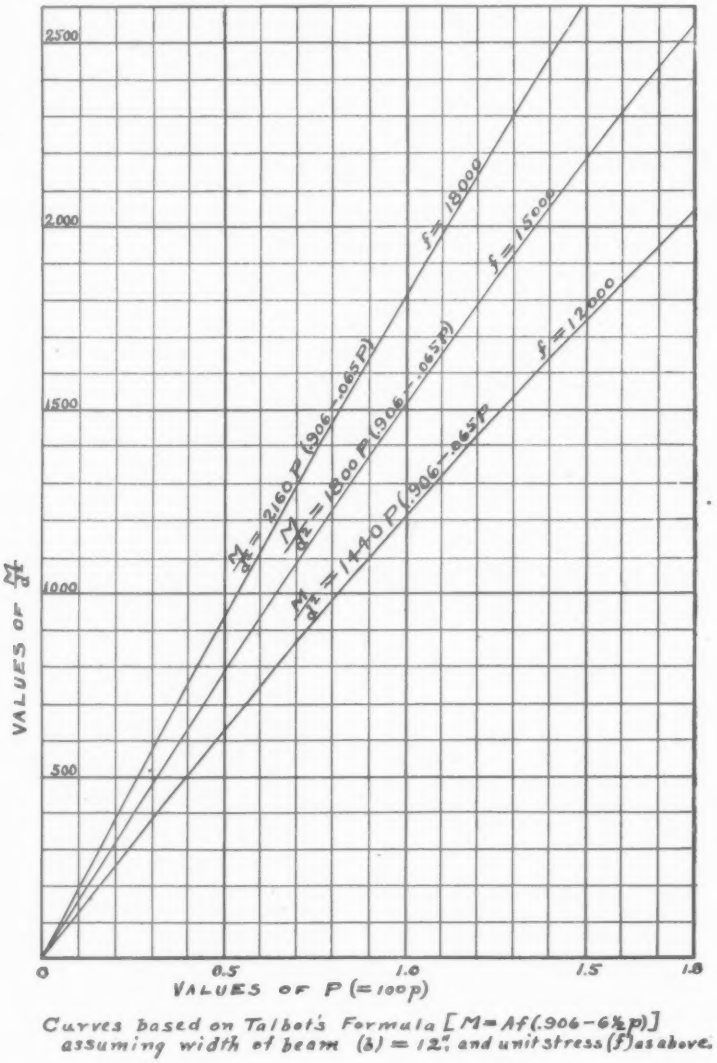
Apparently if the concrete is of uniform strength the beams will vary in strength directly as the strength of the bars, depending upon the area and elastic limit of such bars, and the bond between bars and the concrete.

It generally will be found economical to use between 0.7 per cent. and 1.0 per cent. of reinforcing metal for average rock concrete. For extra strong concrete of about 1 of cement, 2 of sand and 4 of broken stone, the percentage of reinforcing may be increased to 1.25 per cent. but

dron, cracks were first seen at points corresponding to stresses in the steel ranging from 10,000 to 30,000 pounds per square inch. Other experimenters have found a similar range.

2. The similarity of characteristics between reinforced concrete beams and steel beams must not be carried too far. The statement that the beam recovers when the load is removed is inaccurate. In tests reported in Bulletin No. 1 of the University of Illinois engineering experiment station, referred to by Mr. Condron, it is shown that reinforced concrete beams, upon the release of the loads, retained 40 per cent. of the deflection and 40 per cent. of the apparent stretch in the steel for loads which presumably stressed the steel to 25,000 pounds per square inch. This considerable stretch remaining in the steel after the removal of the load, corresponding to 10,000

pounds per square inch in the steel in the above instance, is quite unlike the action of steel beams. For both lower and higher loads, the observations show that the beam fails to return to its original condition, both on the tension and on the compression side. Again, the appearance of large cracks in general occurs after the elastic limit is reached rather than when the steel is approaching its elastic limit.



Curves based on Talbot's Formula [M = Af(.906 - 6½p)] assuming width of beam (b) = 12", and unit stress (f) as above.

FIG. 13.

3. It would seem that so important a statement as that it is necessary to have a positive bond between the steel and concrete to develop the strength of high elastic limit steel, is entitled to a fuller explanation, discussion, and proof than a mere reference to the results of the tests at the University of Wisconsin. Prof. Turneaure makes quite a different interpretation of the tests. Even if slipping occurred in the beams with high elastic limit metal, it should be noted that these were short beams and that the bond developed between the concrete and steel must have amounted at the ultimate load to something like 250 to 400 pounds per square inch of surface of rod, the load being but 20 to 30 inches from the end supports. Whatever may

be the relative merits of plain and deformed bars, it would seem that length of span and method of loading should be considered in a discussion of the effect of a change in the elastic limit of metal.

H. P. Boardman—The straight line equation shown by Mr. Condron on his diagrams, is convenient for designing beams. By assuming a working stress of 15,000 pounds per square inch in the steel (for Johnson corrugated or Ransome twisted bars) and calling b the width equals 12 inches, I have worked up a similar diagram for Prof. Talbot's formula. Fig. 13.

This formula is M equals Af (.906 minus 6 1-2p) d, where M equals moment of resistance in inch pounds.

A equals area of steel in tension.

f equals unit stress in steel.

p equals A divided by bd equals ratio of steel to concrete above the steel reinforced rods.

d equals depth of beam above the steel in inches.

By making the above assumptions, the following equation is obtained:

$$\frac{M}{d^2} = 1800\,P\,(0.906 - 0.065\,P).$$

where P equals 100p. This when plotted with values of P for abscissae and M divided by bd square for ordinates, gives a slightly curved line, which amounts to practically the same thing as Mr. Condron's line M divided by bd square equals 450P plus 55, with a factor of safety of 4 between limits P equals 0.5 and P equals 1.5. For lower values of P this curved line gives larger factors of safety than 4, when compared with Mr. Condron's formula, reaching a factor of safety of 4.6 for 0.3 per cent., and of 7.5 per cent. for 0.1 per cent. of reinforcing.

T. L. Condron—The investigation of these test results leads the author to offer empirical formulas by which to design reinforced concrete beams. Such formulas in his opinion will be as safe and as consistent with actual conditions as are the more complex formulas based upon purely theoretical conditions, since the variations in the physical properties of concrete and steel make an exact analysis of the strength of any combination of the two almost impossible. In determining the compression stresses in the concrete for various percentages of reinforcing and different stresses per square inch in the steel bars, the author has used the parabolic method, and the ratios of depth of neutral axis to the depth of plane of bars, below compressed surface of beam, given in Taylor and Thompson's treatise on Concrete. The working formulas deduced from the results of these tests and proposed by the author, and the table for moments of resistance and corresponding compression stresses in concrete are as follows:

(1) $$M_R = \frac{S\,b\,d^2}{60{,}000}\,(500\,P + 50) \quad \text{or} \quad M_R = \frac{S b d^2}{120}\,(P + \frac{1}{10});$$

(2) $$P = \frac{120\,M_R}{S\,b\,d^2} - \frac{1}{10}; \qquad (3) \quad d = \sqrt{\frac{120\,M_R}{S\,b}\,(P + \frac{1}{10})}$$

and (4) $$a = \frac{1.2\,M_R}{S\,d} - \frac{b\,d}{1{,}000}$$

TABLE OF VALUES OF M_R AND C (COMPRESSION IN CONCRETE IN POUNDS PER SQUARE INCH) FOR VARYING VALUES OF S.

S*	For P=0.5%		For P=0.75%		For P=1.0%		For P=1.25%	
	M_R =	C	M_R =	C	M_R =	C	M_R =	C
60,000	300, bd²	1667	425, bd²	2110	550, bd²	2500	675, bd²	2880
40,000	200, "	1110	283, "	1406	367, "	1667	450, "	1920
30,000	150, "	833	212, "	1055	275, "	1250	338, "	1440
20,000	100, "	555	142, "	703	183, "	833	225, "	960
18,000	90, "	500	128, "	633	165, "	750	203, "	864
15,000	75, "	417	106, "	528	137.5, "	625	169, "	720
12,000	60, "	333	85, "	422	111, "	500	135, "	576
10,000	50, "	278	71, "	352	92, "	417	112, "	480

* NOTE.—S can never be greater than the elastic limit of the bars used, for when S = elastic limit, M_R = Ultimate Moment of resistance of the beam. When S = Safe stress in the steel, M_R = Safe Moment of resistance for the beam.

M subscript R equals moment of resistance of beam in inch pounds for corresponding values of S.

S equals tension in bars in pounds per square inch.

b equals breadth of beam in inches.

d equals depth of beam to plane of bars, in inches.

P equals percentage of reinforcing equals 100 multiplied by area of bars divided by bd.

a equals area of bars in the beam.

It must be borne in mind, that when the stress in the steel is beyond the elastic limit, the steel stretches rapidly, the position of the neutral plane changes and therefore no formula that is good inside of the elastic limit of the steel applies beyond that point. In fact, the ultimate strength of the beam is practically coincident with the elastic limit in the bars, provided the concrete does not fail in crushing before the bars are stressed to their elastic limit.

For usual working condition with average rock concrete, P may be taken at 0.75 per cent and S at 15,000 pounds; gives:

$$M_R = 106\ b\ d^2;\ d = \sqrt{\frac{M_R}{106\ b;}}\ \text{and}\ C = 528.$$

For a special rock concrete the value of P may be raised to 1.0 per cent. and the value of S at 15,000 pounds, gives:

$$M = 137.5\ b\ d^2;\ = \sqrt{\frac{M_R}{137.5\ b;}}\ \text{and}\ C = 625.$$

And the factor of safety will be 2 1-3 for ordinary mild steel bars, and 4 for high tensile bars with positive bond.

MINIMUM WATER METER RATE.

By Jay A. Winans, Los Angeles. Cal.

In the article on "Meter Rates" in the June number of MUNICIPAL ENGINEERING, speaking of the minimum rate for taps, the matter of whether this charge should be in addition to the regular meter charge for water, or should allow a given amount of water, after which an additional charge should be made for water used, the writer correctly says that the question is usually answered by the choice of the latter method, but he inserts the remark "very properly." It is to this remark that exception is taken.

The point, while apparently an insignificant one, is really one of the first importance, both from the standpoint of expediency and justice.

Some years ago, while employed by a private water company, whose rate for water was 20 cents per hundred cubic feet without any minimum, I found that from seventy average customers served through meters, the returns averaged but 20 cents each per month during two months when we had copious rainfall, so that there would have been no use but strictly domestic.

An examination of the records of the municipal system which has absorbed the private system shows that under the system of rating now in force, the same customers during months of copious rainfall use an average of two hundred cubic feet. The municipal rates are 7 cents per hundred cubic feet, with a minimum of $1 per month. No extra charge being made unless more than fourteen hundred cubic feet is used.

Most authorities whom I have read upon the subject have estimated the saving effected by adopting the meter system at approximately 50 per cent.

The presumption is that the authorities have based their estimates on results as produced by meters with a minimum rate charged. Had they been able to get figures from a system with no minimum, it would have been interesting to see the difference. It is true that it would probably not exceed 3 or 4 per cent. because the largest saving effected by meters is to shut off leaks, but after the expense is in, an additional saving of even 1 per cent. should not be overlooked, especially when it can be effected and at the same time greater justice in the rates secured.

Many frugal people are not above saving a cent here and there, and the habit is one to encourage, not to discourage. Yet we certainly are discouraging it when we charge a dollar whether one foot or fourteen hundred feet of water be used.

To what extent it is a discouragement may be judged from the fact that many times one hears the remark, "Well, if I have to pay for it, I am going to use it, whether I need it or not."

I say many is the time I have heard the remark, and from good people, too. One instinctively feels the injustice and resents it. Perhaps he does not know anything about the theory of service rent but he does about paying for what he does not get.

Then it is unjust. Why should the small consumers be made to pay the whole of the maintenance of service and

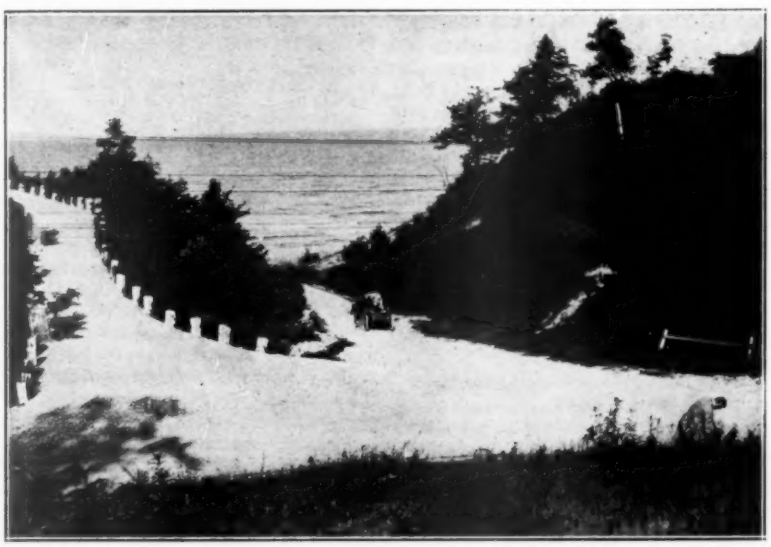
the large not a cent? That is just the effect of a minimum charge.

For what cares a man who habitually uses five dollars worth of water, if you do charge a one dollar minimum. The minimum is only such to the small consumer, and to him it is an incentive to waste. I estimate that a meter or service rent of 25 cents is as good to the municipality as a minimum of one dollar per month. Yet see the effect a small consumer whose use averages say two hundred feet per month would pay. Service rent, 25 cents, for water, 15 cents, making 40 cents per month, or $4.80 per year, as against $12, a difference of $7.20. Quite a difference for a poor man, while to the one who pays $5 it adds just $3 per year, each paying $3 plus water used, thus distributing equally the burden of service maintenance.

There is another point of advantage in the system of charging a fixed service rent, equal in all cases, and then an additional charge per hundred feet for water used. That is in the balance it give the accountant, the check on the correctness of his computations. With that system in force he could compute the whole consumption which at the given rate should balance the total charges less the service rent. This is not of great importance though quite a convenience.

The author of the article above referred to started out to give a logical system of rating. Now I claim that the first requirement of a logical system of rating is to place the charge where it belongs, and it does not seem to me to admit of a question that is not placing the charge of service maintenance where it belongs when it is merged with the charge for water. It should be kept separate and distinct.

I am ready to admit that possibly a private corporation, in order to squeeze out a few more dollars, might properly vary from strict logic in fixing rates, but a municipality, never.



ON SHERIDAN DRIVE, NORTH OF CHICAGO.

EDITORIAL COMMENT

A Text Book on Highway Construction.

Foreign Cement Trade.

Asphalt for Paving.

Tests of Fire Proof Materials.

A TEXT BOOK ON HIGHWAY CONSTRUCTION.

The ninth annual report of the Commissioner of Highways of Ontario, for 1904, has just been received and a cursory examination of it shows that it is a very complete textbook upon the construction of highways under the conditions existing in the Province of Ontario, including first the laws and the details of the duties of officials under the laws; second, instructions to road officials upon methods of doing work, quality of materials, methods of securing the best materials, methods of inspection and repair; third, descriptions of road systems in various counties as examples of what has been done and what should be done, and conclusions as to the advisability of the various methods used; fourth, the descriptions of the best constructions for roads, including dimensions, materials, gravel and stone, method of hauling and placing materials, drainage, hills, cuts and embankments, swamps, etc.; fifth, methods of repairing roads, the use of graders, rollers and crushers, with data as to cost in various towns; sixth, the use of concrete tile culverts, abutments, arches, bridge floors and foundations with full specifications for all of them.

A significant chapter is that on snow roads and the serious effects of lack of snow upon roads exposed to winds. A table shows the bonuses paid by townships for fences of wire, so designed as to retain the snow on the roads. Width of sleighs and width of tires have been subjects of legislation.

Short descriptions of street improvements for towns and villages are included in the book, macadam, sheet and block asphalt, brick, concrete, tar macadam and bitulithic receiving notice and full specifications being given for macadam street construction.

The reports of work and of apparatus on hand for doing work in the various townships take but little space.

The issue of such a book as this in the form of a state report ought to result in spreading the knowledge of construction suitable to the conditions and to aid materially in the molding of public opinion in favor of the expenditures to secure better roads. It is missionary work such as is done by the United States Bureau of Road Inquiry, but more detailed and more directly applied to the existing conditions in the district covered and should receive the aid and encouragement of all those interested in the development of the province. The example could be followed to advantage by other states.

FOREIGN CEMENT TRADE.

There are some interesting figures in the last "Monthly Summary of Commerce and Finance," issued by the Bureau of Statistics of the United States Department of Commerce and Labor, regarding our foreign cement trade, which show that the conditions of the past are now in process of reversal.

The imports of cement from abroad were as follows for the years ending June 30, reduced to barrels of 380 pounds each:

	1903.	1904.	1905.
Barrels ..	2,922,428	1,606,031	1,007,248
Value	$3,547,914	$1,993,303	:1,276,597
Value, per bbl.	$1.21	$1.24	$1.26

The exports of American cement for the same years have been:

	1903.	1904.	1905.
Barrels ..	271,272	362,503	1,067,284
Value	$419,361	$530,216	$1,484,795
Value, per bbl.	$1.54	$1.46	$1.39

The re-exportations of foreign cement have not been far from 40,000 barrels a year, of little account in this consideration.

The increase in value of imported cement is pronounced, though slight, at the same time that the amount imported has been greatly reduced. One reason for this may perhaps be found in the fact that a certain amount of cement must always be imported to supply the demands of those who will be satisfied only with certain brands, and also in the fact that as the importation of ordinary Portland and natural cement decreases the effect of the higher prices of particular kinds of cement, such as non-staining cements, becomes more pronounced.

The value of exported American cement has decreased very materially.

These reports of the Department of Commerce and Labor can be compared with those of the United States Geological Survey, which are quoted in the "Handbook for Cement Users," if it is remembered that the latter uses the calendar year ending six months later than the former's year here considered. The comparisons show that the value of exported cement in 1903 was 30 cents a barrel greater than the value of the cement at the mill, the difference probably being largely due to the freight from mill to point of shipment. Values at mill were lower in 1904 and early in 1905, probably about the same amount, so that the values of American cement at the mill may be estimated throughout as about 30 cents below the values of exported cement per barrel.

The reduction in production in the early months of 1905 and the consequent more nearly equal start of production and consumption with the building season of 1905 have increased the price of cement for domestic consumers and may reduce the amount exported for the last half of 1905. However, as the manufacture of cement becomes more nearly a local matter, the numerous cement plants in the eastern Pennsylvania districts will probably find more of their market in foreign countries and the former excess of imports, which is displaced in the year ending June 30, 1905, by a practical equality of imports and exports will doubtless become an excess of exports for each year hereafter.

ASPHALT FOR PAVING.

The paper read by Mr. Andrew Rosewater before the League of American Municipalities, at its meeting in Toledo, August 24, is the most complete exposition of the factors which influence the design, construction, maintenance and cost of artificial asphalt pavements which has appeared for some years. The asphalt pavement has lost some of its prominence in the discussion of paving materials since the changes in the methods of promoting the pavement were made by the new owners of the prominent foreign asphalt deposits and of the principal contracting companies laying asphalt pavements. Nevertheless, many miles of asphalt pavement are laid each year and Mr. Rosewater's paper is worthy of careful reading because it shows why the asphalt pavement can be successful and shows what the engineer and the municipality must do to insure its success.

The paper should be compared with those upon other paving materials which have appeared in MUNICIPAL ENGINEERING from time to time, by those who are preparing to design pavements for their cities. It will be worth while, also, to compare it with papers on natural asphalt rock for street pavements of various qualities in this and other numbers of this magazine.

The emphasis laid in the paper upon the small proportion of asphalt in the pavement, and upon the many forms in which this asphalt can be used is warranted by the developments of recent years. The necessity of filling the voids of the materials of which the pavement is made with the asphaltic cement is also well shown. An asphalt pavement must be as waterproof as any other pavement and for the same reasons, and Mr. Rosewater adds the reason which most engineers have recognized for years, that asphalt itself is, in most of its forms, subject to deterioration when soaked with water. A waterproof pavement, laid so that the water reaching it will drain off, should have indefinite life so far as this characteristic is concerned.

Mr. Rosewater has not been operating his asphalt repair plant long enough to enable him to furnish figures of the cost of operations, or to report his success in doing good work. He evidently agrees with the opinion of Mr. Proctor, the inspector in charge of the Detroit municipal asphalt repair plant, that the work of repair can be done more cheaply by the city and more satisfactorily, since breaks are taken care of before they have developed into large holes.

The necessity of securing and retaining expert employes for such a plant is pointed out. This is only another evidence of the growing idea that a municipality should be treated as a business organization and be operated on business principles, so that, whatever changes may be made in the policy upon which the public improvements are based or the heads under which it is applied, there shall be no changes in the technical men who do the actual work, beyond those which will improve the service. Unless a city is ready to recognize this necessity it had better not put in an asphalt repair plant of its own, or engage in the operation of any other public utility requiring experts and men familiar with their duties and with the plant.

TESTS OF FIRE PROOF MATERIALS.

The British Fire Prevention Committee is an incorporated society composed of government, county and city officials

in the technical department, insurance surveyors and other architects and engineers.

It claims priority as an organization to investigate systematically the fire resisting qualities of various methods of building construction and that its ideas are the basis of the testing stations which have been established in Berlin, New York, Boston and Chicago, and also that it now has the most completely equipped station, as regards materials, apparatus and men, which is in operation.

The public benefit which has been derived from the movement which these gentlemen have inaugurated is incalculable and that it is entirely disinterested is shown by the statement that the members of the committee render their services gratuitously. As stated in this department recently, those who are really most interested in securing the data get little or no individual return for their expenditures, and it has therefore been difficult to start the investigations. The British committee deserves special commendation for stepping into the breach in so self-sacrificing a manner. Heretofore the stations in this country have been able to operate only on a very small scale upon infinitestimal appropriations made by colleges, individuals or insurance committees, except when some inventor or promoter of a new method of fireproof construction has been willing to pay the expense of tests of his particular system. A start is now making under United States government direction, which should soon develop into something more comprehensive and more stable than anything which has heretofore been possible.

A brief description of the British Fire Prevention Committee's station, taken from *The Surveyor and Municipal Engineer* of London, will be of interest:

The main plant for testing building comprises a set of testing huts, in which floors, partitions, doors, ceilings, etc., can be tested. The huts are laid down in two rows. The materials used in their construction are stock bricks with lime mortar.

The fuel generally used is gas, produced on the spot by a generator supplied by Messrs. Mason, of Manchester. The gas is conveyed from the generator by pipes to the several huts, and the supply is regulated by valves and dampers, and as the gas enters the huts from the branch pipes it is diffused by means of mixing chambers of fire-brick. Each hut has door-openings, ventilation and observation holes, the doors being closed by brickwork during a test, and the ventilation holes blocked, according to requirements, by fire-brick or fire-clay. Each chamber for a floor test allows for the floor under investigation to be placed at least 8 feet above the floor of the hut. The chambers are roofed in with galvanized iron or tarpaulin, when necessary. Bricks or pig iron are used for any loads that may be applied to floors under investigation, and water is applied from a steam fire engine, or from a manual pump as required.

Records of temperatures are taken as far as possible by pyrometers. The instruments used are recording pyrometers, designed by the late Sir William Chandler Roberts-Austen, K. C. B., F. R. S., and manufactured by Messrs. James Pitkin & Co., of London. Accurate indications of temperature up to 3,000 degrees Fahrenheit are given, which is considerably higher than has so far been required at the testing station. Visual observations as to work under investigation are also recorded, as far as possible, by photography.

THE QUESTION DEPARTMENT

WATERPROOFING FOR CEMENT BLOCKS.

I want a formula for making cement blocks waterproof, one that you know to be right.

E. F. A., Kansas City, Kans.

The best the writer can do is to refer this correspondent to the firms whose names are in the "Business Directory," printed in each number of MUNICIPAL ENGINEERING, under the headings, "Damp-Proof Coatings," "Water and Damp-Proofing Walls" and "Waterproofing Formulae." Which is best depends largely upon the local conditions. Inert substances or chemicals which can have no action on the ingredients on the concrete are necessary for durability of the concrete and permanent substances, which will not need future renewal, are also desirable.

The various articles on the market ap-

proach more or less closely to these requirements and the purchaser should know how closely, that he may make an intelligent decision. Information can be obtained through chemical analysis if not in any other way.

See also article in this department on "Lime and Concrete Blocks." A wash of cement and lime may even be applied to the surface of the blocks with some success.

LIME IN CONCRETE BLOCKS.

Give me the best formula for mixing sand and lime for cement blocks.
A. M., Phillipsburg, N. J.

This is not definitely determined as yet by experiment. The "Handbook for Cement Users" ($3) gives several different proportions of cement, lime and sand required to make waterproof mortar, choice to be made according to the strength required of the concrete. All these require thoroughly slaked lime, as any unhydrated lime will disintegrate the block. Whether the lime will dissolve out of the block, and if so, how long time will elapse before the block is seriously affected, are questions which have not yet been answered. The proportions in the mortar vary from 1 part cement, 1-2 part lime putty and 1 part sand, to 1 part cement, 2 parts lime putty and 6 parts sand. These mixtures should make the blocks waterproof, but they are intended for plastering, where there is no requirement of compressive strength, and if used in blocks, the diminution in compression strength of the blocks must not be forgotten. Smaller proportions of lime may be used with consequent increase in strength of block, but at the same time increase in porosity.

HOW TO MAKE BASEMENT WATER TIGHT.

In the spring of 1904 I laid a cement floor (2-inch limestone concrete, 6—1, 1 inch finishing coat, 2—1) in basement of a wareroom, floor surface, about 2,000 square feet. The building is located near the river, and the basement floor is about water level when river is normal. We had hoped to make basement water tight, but at high flood time this spring the floor was subjected to a severe test—a two foot head of water—and was found wanting. The water gained entrance through the seams—the places where sections of the floor laid on consecutive days joined. The question now is—what should be done to secure water tightness? Would the desired result be obtained by taking out two or three inches of the floor at the seams and refill space with a strong mortar of sand and cement? Would a layer of finishing coat, about 1 1-2 inches in thickness over whole surface, insure better results?
G. I. T., Clearfield, Pa.

If the water came in through the seams or joints in the floor, probably the first step would be to dig out the joints and fill them with asphalt or tar, preceded by some oakum soaked in the same material and thoroughly driven in, while hot. A finishing coat forming a thick plaster, perhaps as much as a half-inch thick, laid over the whole surface, would aid if the concrete itself is porous near the joints or elsewhere. Will some of our readers describe their methods of meeting such a difficulty?

CURING ARTIFICIAL STONE IN WATER.

I would like to know if any one has had experience in curing artificial stone in water. How soon may they be put in the water and how long should they remain? Are they better than usual way.
E. N. A., Alexandria, Neb.

This is referred to our readers for answer as to the results of their experiments. The blocks may be put into water as soon as they are set enough to handle. They will cure more slowly than in air, and will form a hard layer on the surface, which seems to be extremely subject to hair cracks if the blocks are dried out too quickly or subjected too quickly to great changes in temperature, especially if stored in the sun. The length of time required in the additional handling and the careful attention to prevent hair cracks are the reasons which have been given by experimenters thus far for not curing the blocks in water.

Some experimenters have apparently had better results with steam.

WHITE PORTLAND CEMENT.

Pending the development of the white Portland cement, which was suggested in the August number of MUNICIPAL ENGINEERING as possible, the following letter will give a suggestion of the proper procedure to follow, remembering that there are several cements made in the same vicinity as well as occasionally one elsewhere which have properties similar to the Dexter:

We have noted from time to time frequent inquiries in your interesting correspondence department concerning white Portland cement, or light colored Portland cement.

We believe that a white Portland cement has so far not been successfully produced on account of the highly aluminous character of the kaolin clays which would have to be used.

The lightest colored Portland cement in the market is, we believe, Dexter Portland cement. Its color is an exceedingly light pearly gray, free from yellowish blotches or discolorations and very uniform in the color of different shipments. You are doubtless aware that many Port-

land cements show markedly different colors in different carloads.

Because of its light uniform color, Dexter Portland cement makes beautiful concrete blocks and cement sidewalks, and has found much favor for these purposes.

SAMUEL H. FRENCH & Co.,
Philadelphia, Pa.

SLIPPERY CEMENT WALKS.

Can you recommend any way to make cement walks non-slippery that will not add to cost of same? How is crusher dust and coarse sand?

J. J. A. & Co., Bridgeport, Conn.

Cement walks are slippery because there is too much fine material on the surface, either because the sand troweled to the surface is too fine or because there is too much cement on the surface. The more sand there is in the top coat, up to 1 1-2 or even 2 parts to 1 of cement, the less probability there is of a slippery surface. Coarse sand or fine crushed granite or other hard stone will aid in taking off the slipperiness. Finely crushed dust would have the same effect as fine sand. Fine crushed granite or quartz with the dust removed is recommended by many engineers and contractors.

CURING OF CONCRETE.

I have been surprised at the dearth of authentic information in all cement literature relative to the curing of cement work. If I have not overlooked it the paragraph from the paper by James Wimmer, before the Iowa state convention, is the only thing in your Handbook on that very important point, and I find practically nothing in either Hagloch, Eno, Sabin or Baker.

We men in the field want to know from properly conducted laboratory tests how long continued wetting of our product is practically necessary and at what age hardening will be facilitated by the absence of water.

Orthodox cement directions call for frequent sprinkling for ten days to two weeks, enough and frequent enough to prevent drying out of any part of the product.

On the other hand, heretical as it may seem, I know of a successful firm in the manufacture of thin-shelled dry tamped cement two-foot tile, who thoroughly sprinkle the tile the next morning after making, and but that once. They are left in the factory until the fourth or fifth day and then rolled into the yard and given no further attention.

Is it not possible that for practical purposes we have been laying too much stress on water soakage and that the formation of the interlocking cement crystal in ordinary temperature and with abundant moisture really is in a large measure completed within a much shorter time than we have been accustomed to think and that the hardening of these crystals already formed is rather accelerated by absence of water? We all have noticed that cement products allowed to dry the last two days are much stronger at the end of four to six days than those kept wet all the while.

We want to make the very best products possible, but we don't want to waste time in unnecessary sprinkling and retard hardening by keeping it up after a practical amount of crystallization has taken place.

L. L. B., Estherville, Iowa.

The amount of water to be applied to a block, walk or wall, the time at which to apply it, and the number of days on which applications of water should be made, as well as the covering of the green concrete to protect it from the sun or the air, are variables which depend on many conditions. The amount of water used in making the concrete, the method of tamping and finishing, the condition of the surface, the constitution of the sand or stone, the peculiarities of the cement, the temperature, the suddenness of changes of temperature, the heat of the sun, the humidity of the atmosphere are some of the conditions which affect the curing of the blocks. Some of these conditions have been studied carefully, others are still open to experiment. Their proper treatment forms the principal "secret of the trade" and the success which German and English cement workers have in making ornamental stone is due to long apprenticeship during which the instincts for proper allowance for the variations in the many conditions have been developed. Some of these men fail under American climatic conditions and with American cements.

It is not possible at this time, and it may never be possible, to reduce the curing of blocks or concrete to rule. Experience, together with some understanding of the scientific basis for the variations in conditions, is the safest teacher, but even then one must not be too dogmatic in applying his experience to his own work or in impressing it upon others. Conditions change and individuals have different ways of arriving at the same result. Reports from the men in the actual work will be most acceptable.

HAIR CHECKING OF CONCRETE SURFACES.

If there is anything in your "Handbook" or back numbers of your magazine that will give me a sure way of presenting hair checks, please send it to me at once. Is there any way when the work is hair checked to fill them and prevent them showing again? I today had to replace a set of molded steps by sand-stone, on account of the pesky checks, and am $25 poorer by the transaction.

T. P. G., Detroit, Mich.

Hair checking of concrete surfaces is usually attributed to one or both of two faults.

If the surface is troweled too much in finishing, a skim of neat cement may form on the surface, in which the checks

appear. On a horizontal surface of walk or steps the checks are worn off, but on a vertical surface they remain.

Even if there is not the great excess of neat cement on the surface, which is described above, the surface may show hair checks, or even more pronounced checks, if it is subjected to great differences in temperature or to too sudden drying out in the sun before the concrete is, not only thoroughly set, but thoroughly cured. Exposure to the sun too soon or when the concrete is still wet on the surface is the most common act causing this trouble. But contractors of long experience have occasional troubles with hair cracks which they do not seem to be able to attribute to these causes or to assign to any other error in manipulation.

The writer knows of no method of filling the cracks, but would suggest a careful dressing of the surface with stone cutters' tools of some sort, probably hammers, to remove the thin surface skin in which the cracks have appeared.

HOW TO BUILD CONCRETE CULVERTS.

Will the "Handbook for Cement Users" give me information on building concrete culverts of about 12 feet span?

W. W. V., Joplin, Mo.

Everything required in the construction of such culverts is described in the book referred to, and dimensions of existing structures are given. Designs for culverts for particular locations must be made for the conditions of waterway, loading, span, etc.

CEMENT ROOF AND PLASTER.

We would like your advice about using cement and sand for a gravel roof. Please also let us know if it will do for flashing the fire walls.

W. & Co., Carthage, Mo.

Cement would not make a satisfactory roof if used in the manner indicated. Successful roofs have been made of reinforced concrete slabs, but they are special constructions requiring special designs and have considerable weight. Portland cement can be used for plastering, and on interior walls may be used with lime and sand as described in the "Handbook for Cement Users" ($3).

CONCRETE RESERVOIR WALLS AND ROOF.

This city is wanting a reservoir to hold water for city use. Our site is such as would require building a part of this reservoir above ground to have it as we would like. We wish one of a capacity of 300,000 gallons. The space is such we can have one about 66x34x20, inside measure. To have this reservoir the height desired we would have to excavate about six feet in the rock. Above this, on one side, we would like the wall exposed some fourteen feet above excavation; also on one end, as on this side and end an alley must be maintained.

A question arises among the councilmen as to our being able to construct it with walls exposed and have it durable. We wish to build of concrete and cover with same. Some tell us we can put the roof on and not use steel beams, but use concrete beams. Have you any knowledge or any printed matter pertaining to reservoirs being built of concrete and roof supported by concrete beams, same standing in part or wholly above ground?

B. W. J., ————, Iowa.

The reservoir can doubtless be built in the manner described and be durable and satisfactory. There are many structures in existence in which all the problems here mentioned have been successfully solved. Some of these are described in back numbers of MUNICIPAL ENGINEERING. Descriptions of others will be found in such books as Marsh's "Reinforced Concrete" ($7), Taylor and Thompson's "Concrete, Plain and Reinforced" ($5), and Buel and Hill's "Reinforced Concrete" ($5). The walls can be exposed to the weather and the roof can be supported by reinforced concrete beams, not using I-beams or girders.

Such a structure should be built only upon the plans and under the supervision of a competent engineer. Not only must the walls and roof, as well as the foundation, be properly designed by an experienced technical expert, but the construction must be supervised by one equally competent and experienced if satisfaction is to be insured.

HOW TO BUILD CONCRETE ARCHES.

I have been recommended to make inquiry of you in regard to the building of concrete arches for bridges on public roads. If you can give me information on this subject I shall be greatly obliged.

E. B. P., Mendenhall, Pa.

General information on the subject, specifications for the cement and concrete and instructions for this part of the work can be found in the "Handbook for Cement Users" ($3) and in the current volumes of MUNICIPAL ENGINEERING. Plans for such structures should be made by competent engineers. Considerable information can be gathered from the catalogues of contractors and dealers in materials for making and reinforcing concrete. These can be obtained from the firms named in the "Business Directory" published in each number of MUNICIPAL ENGINEERING, under the headings, "Bridges," "Cement," "Civil Engineers," "Concrete Construction Machinery,"

"Concrete Steel Arch Bridges," "Concrete Work," "Contractors," "Contractors' Supplies," "Consulting Engineers," "Expanded Metal Construction," "Concrete Foundations." Books containing information on the subject are Sabin's "Cement and Concrete" ($5), Marsh's "Reinforced Concrete" ($7), Taylor and Thompson's "Concrete, Plain and Reinforced" ($5), Buell and Hill's "Reinforced Concrete" ($5).

CATALOGUE OF CEMENT BLOCK DWELLINGS.

Will you kindly inform me where I might obtain illustrated and explanatory catalogue of cement block dwellings, plans of the buildings and cuts of same? I have in mind the erection of a six or seven room cement block cottage, and will appreciate the above information.

B. B. D., Blue Mound, Ill.

The catalogues of the makers of cement block machinery are the best sources of such plans. Consult the "Business Directory" printed in each number of MUNICIPAL ENGINEERING for names of firms, under the headings, "Concrete Blocks" and "Concrete Construction Machinery."

MONOLITHIC CONCRETE HOUSES IN NEW YORK.

Do you know of any monolithic concrete apartment houses or private dwellings in course of construction in the vicinity of New York at the present time?

J. B., Brooklyn, N. Y.

This question is referred to our readers in New York. Inquiry may also be made of the firms in this vicinity whose names are in the "Business Directory" printed in each number of MUNICIPAL ENGINEERING, under the headings, "Concrete Work" and "Contractors."

FACTORIES OF CONCRETE BLOCKS.

I notice on page 100 of the August number of MUNICIPAL ENGINEERING, a request from A. S. R. for information in regard to factories of concrete blocks. I built last year, in this place, one for the Gillette Skirt Company, "mill construction," which carries sewing and cutting machines on second and third floors. I also built one for the Ekenberg Milk Products Company of hollow blocks wall, and the rest of the building of reinforced work which carries heavy machinery, some weighing five tons, on both second and third floors. The building stands the work all right and shows no breaks or strain.

If I can give A. S. R. any information on the subject I would be glad to do so.

MYSON OOUTHOUDT,
Cortland, N. Y.

BUILDING INSPECTORS' REQUIREMENTS CONCERNING HOLLOW CONCRETE BLOCKS.

Can you send us the requirements of the Bureau of Building Inspectors of any of the western cities for tests of hollow concrete blocks?

H. S. S., Philadelphia.

Will our readers answer this question? The material is no new that no printed building regulations have been received at this office containing instructions regarding hollow concrete block construction. There have been some complaints of local requirements, so that there must be a few cities in which the building departments have taken up the subject. Our readers will aid the cause if they will send us the regulations in their cities if any have been adopted.

STRENGTH OF HOLLOW CONCRETE BLOCKS.

We have been referred to you by the Century Cement Machine Co. of Rochester, N. Y., in regard to a report of tests made on hollow concrete blocks. Our Bureau of Building Inspection requires such a test and would greatly appreciate if you will give us any tests you may have made.

ARTIFICIAL STONE MFG. CO.,
Philadelphia, Pa.

There have been but few determinations of the strength of hollow concrete blocks. Statements of results of tests will be found in MUNICIPAL ENGINEERING, vol. xxvi, p. 426; vol. xxiv, p. 457; vol. xxvii, p. 371; vol. xxviii, p. 125, and in this number.

CITY ENGINEER'S RECORDS.

What book have you on how to keep city engineering records, etc.?

G. C., Maryville, Mo.

Johnson's "Theory and Practice of Surveying" ($4) and Staley's Gillespie's "Higher Surveying" ($3) contain chapters upon this subject.

The system of records in the city engineer's office at Burlington, Ia., is described in MUNICIPAL ENGINEERING, vol. viii, p. 236. The office of the city engineer in Providence, R. I., was described in *Engineering News*, April 24 and May 1, 1880, including office records and methods and apparatus for filing and indexing.

CONCRETE BLOCKS FOR VENEERING.

Where can we get information on the construction of barns and other farm buildings using a cement veneer?

H. C. F., Des Moines, Iowa.

The "Handbook for Cement Users" ($3) or the back numbers of MUNICIPAL

ENGINEERING ($2 a year) will give full information as to how to make the blocks. "How to Make Hollow Concrete Blocks" (50 cents) will also give some instructions.

They must be attached to the frame of the barn with frequent ties in the same way that stone veneer is put on frame houses. Wires, bolts or wall-ties are used for this purpose by different contractors and according to the design of the frame. Will any of our readers send us descriptions of their methods of setting concrete block veneers on frame buildings or on old brick buildings?

HAND TAMPED AND MACHINE PRESSED CONCRETE BLOCKS.

I would like to ask for information on hand tamped and machine pressed cement blocks. We have a party here making pressed blocks 4x8x20 inches for veneering, or for full width of wall, putting blocks on edge and using wire to tie with. The point is, are pressed blocks as strong as hand tamped and will they stand the weather? I would also like to find some one who will furnish designs for cement block houses.

C. H. D., ————, Ind.

There are good blocks on the market made by both the machine pressed and the hand tamped methods. It can not be said, therefore, that either is unsuccessful, though there are many examples of unsuccessful operation of both classes of machines, owing usually to the ignorance of the operators concerning the proper methods of handling cement and concrete and lack of experience in finishing the surfaces of blocks. Each factory must be judged by its own merits and must be its own judge of the economy of operation when first-class blocks are produced.

Names of architects who pay some attention to the design of concrete block buildings have been given in this department in vol. xxviii, pp. 30, 221, 306.

COST OF ASPHALT BLOCK PAVING AND OF CONCRETE COMBINED CURB AND GUTTER.

We want information and prices relating to asphalt block paving and combined concrete curb and gutters.

SANBORN & SANBORN,
Huntington, W. Va.

Baker's "Roads and Pavements" gives the cost in certain contracts for concrete combined curb and gutter as 48 cents a linear foot. Recent bids have been received in Indiana at 60 cents, in Illinois at 57 cents in one town and at 88.5 to 94 cents in another, and in Wisconsin at 34 to 70 cents on one contract.

Baker gives the cost of asphalt blocks as $45 per 1,000 for 4x4x12 inch blocks, or $1.70 a square yard in Toledo, and $33 per 1,000 for blocks 5x12 inches and 3 inches deep, or $1.10 a square yard in New York. These prices were those of 1902. He says the usual cost of the pavement on gravel or broken stone is $1.75 to $2.25 a square yard, being $1.77 in Washington and $2 on 6-inch concrete base.

BOOKS ON ACETYLENE GAS.

Can you inform me where I can obtain any literature on acetylene gas lighting and on method of installing these lights?

G. A. M., Alcatraz Island, Cal.

Gibbs's "Lighting by Acetylene" ($1.50) is said to be the only American book on this subject. Lewes's "Acetylene" ($7) is said to be the best scientific and technical treatise. Leeds and Butterfield's "Acetylene" ($2), and Dye's "Lighting by Acetylene" ($2.50) give English practice.

HOW TO TEST FLUE GASES.

Will you kindly tell me a convenient way of testing flue gases, especially for carbonic acid?

J. A. D., Amherst, N. S.

Orsat's apparatus is the standard for easy determinations and is reasonably accurate as well as convenient of application. Hempel's apparatus can also be applied by an engineer who is not an expert chemist. The Orsat-Muencke apparatus determines carbonic acid, carbonic oxide, oxygen and nitrogen. Scheibler's apparatus is designed for the quantitative volumetric determination of carbonic acid in saturation gas. The apparatus described by Fresenius for the determination of the amount of carbonic acid in the air may also be of use. These are arranged probably in the order of applicability to our correspondent's case. The apparatus can be obtained of the dealers in chemists' and analysts' supplies.

MAKERS OF ODORLESS EXCAVATORS.

The board of health of this city are desirous of procuring an "odorless excavator," they having occasion for the frequent removal of night soil, etc., from cess pools much used in certain localities in their district. Would you kindly furnish me with the address of some concern manufacturing the latest im-

provement in this sanitary appliance, and oblige.

CHAS. W. BECKWITH,
Sec. Local Board of Health, —, N. B.

The Edson Mfg. Co., Boston, Mass., manufacture odorless pumping outfits; also the Odorless Excavating Co., of Boston.

WHERE RATTLER TESTS OF BRICK ARE MADE.

To the laboratories for testing paving brick, named in MUNICIPAL ENGINEERING, vol. xxix, p. 101, may be added that of J. W. Howard, 1 Broadway, New York.

WHO SUPPLIES GRANITE SCREENINGS—DEALERS IN FILTER SAND.

In addition to the names of dealers in granite screenings given in MUNICIPAL ENGINEERING, vol. xxiii, p. 32, vol. xxiv, p. 357, and vol, xxix, pp. 101 and 105, the following have been sent in by correspondents. The inquiries were for sand for filter beds and for hard material for top surface of walks and floors. The firms named furnish materials for one or both of these uses.

The Milwaukee Monument Co., Milwaukee, Wis., operates granite crushers and will furnish quotations for crushed granite.

The Red Wing Filter Sand Co., Red Wing, Minn., is reported to have a pure silica sand for filtration purposes.

Houston Brothers Company, Pittsburg, Pa., will give quotations on limestone siftings, which they claim will give good service for top coat work, granite screenings being too high in price in Ohio for common use.

CEMENT AND CONCRETE

Effect of Heat on Concrete—Cement Specifications—Concrete Building Blocks—Concrete Covering for Water Main.

Investigation of the Effect of Heat Upon the Crushing Strength and Elastic Properties of Concrete.*

BY PROF. IRA H. WOOLSON, Columbia University.

It is well known that concrete in a building construction will withstand the attack of a fierce conflagration for some hours and retain its stability of form and strength. This has been proven by actual fires in buildings, and repeated severe tests upon full-sized floor units and partitions. It is also well known that concrete constructions have occasionally failed during conflagration and during official fire tests being made to determine the efficiency of some particular method of reinforcement. The causes of these failures were not always well defined. Usually they have been directly traceable to defective metal protection, unwise design of structural parts, or to the fact that the concrete was too green when subjected to the test. In some cases, however, the cause of failure was not entirely clear, and much speculation has been rife as to just what degree of heat a concrete would stand before its strength and elasticity would be affected. This study was undertaken as an effort to throw some light upon this interesting subject.

The first step was to ascertain what previous work had already been done along the same line and the results obtained. A careful examination of the transactions of the engineering and scientific societies and the leading American technical journals for several years back furnishes very meager information.

The fire tests of reinforced concrete, such as have been conducted by the British Fire Prevention Association in London, and by the writer in co-operation with the Bureau of Buildings in New York City and elsewhere, have for their purpose the determination of three properties: First, effect of a continuous fire at 1,700 degrees or 2,000 degrees F., for three or four hours; second, effect of the application of a strong stream of water at short range while the material is still at a high temperature; third, amount of deflection due to a load during the fire, and subsequent increased loading to 600 pounds per square foot after the structure has cooled. The methods of construction and character of test are regulated by municipal specifications in this country, and by rules of the British Fire Prevention Committee in England.

The concretes used have included trap, limestone and cinder, and were usually 1-2-4 or 1-2-5 mixtures. The reports of numerous tests of this character were examined, and in most instances the concrete stood the heat and subsequent load-

*A paper before the American Society for Testing Materials.

ing well, but the results were general, and referred to the quality or resistance of a particular construction rather than to specific data regarding the concrete itself. Large numbers of tests of compressive strength and elastic properties have been made upon concretes of various composition and after different preliminary treatments, but no records were found in which the concrete was heated prior to testing.

The report of the United States Arsenal at Watertown, Mass., for 1902, contains data of tests of neat cement cubes of several brands, which were heated before crushing. A synopsis and discussion of these is given by James E. Howard in the May, 1905, issue of *Cement*, and some of his conclusions are given, since it is fair to assume that the action of neat cement under heat should be at least a slight criterion of that of concrete. The following is a summary of the results reported by Mr. Howard:

It was desired to ascertain the effect of elevation of temperature alone without introducing internal strains incident to a state of unequal temperatures in different parts of the specimen. The test pieces were 4-inch cubes cast slightly more than a year previous. Tests were at intervals of from four days to four months after heating. The cubes were gradually raised to the recorded temperatures. The heating took one hour, the maximum temperature was held one hour, and the specimens were then allowed to cool slowly in dry sawdust or powdered asbestos. During the heating the specimens developed fine cracks; these were hardly visible immediately after cooling nor were they one day later. Four days after heating they were generally developed and at eleven days they were nearly at a maximum. The effect upon the crushing strength was not serious when the cracks were fine, as the parts fitted together under pressure.

Table I shows the variation in ultimate crushing strength of the cubes. Each result is an average of three tests. This indicates that there is no decrease in strength up to a temperature of 600 degrees Fahrenheit, but for higher temperatures the strength diminishes quite rapidly.

A search for previous similar investigations was so fruitless it was evident that our explorations were to be conducted in practically an untrodden field, so the method of procedure was the next consideration, the desire being to make the conditions conform as nearly as possible to practice.

Since all the factors which enter the concrete problem are variables, it is extremely difficult to arrive at even a partial solution under any one set of conditions. There is, first, variation in the quality of the cement; second, difference in size, sharpness and cleanness of the sand; third, size and quality of the stone, gravel, slag or cinders used; fourth, variations in the proportions of the three solid ingredients and the amounts of water used, and, fifth, method of mixing and treatment after casting, including age before testing. This latter is quite important, for it is well known that the strength of concrete increases rapidly for a period of six to twelve months after casting and continues to increase slightly up to two or more years.

It was decided to make the concrete a 1-2-4 mixture of cement, sand and three-quarters-inch broken stone, this being a common mixture used in constructing reinforced concrete floors. The cement was supplied by your committee on concrete and consisted of a mixture of different brands of the best grades of Portland. The sand was taken from a quantity being used in the erection of a new building on the university grounds. It was of medium size (90 per cent. passing a twelve-mesh sieve), fair quality, and not especially clean. Two varieties of stone were employed, Hudson river blue limestone and Hudson river trap rock. Two sets of specimens were prepared, which were duplicates in every respect, except that one contained limestone and the other trap rock.

The mixing and casting were done by a laborer familiar with concrete work. A moderately wet mixture was used, tamping in the molds being continued until

TABLE I.

Effect of Previous Heating on Crushing Strength of Neat Cement and 1:1 Sand Mortar. (Watertown Arsenal, 1902. J. E. Howard.)

Composition.		Not Heated.	Ultimate Crushing Strength in lbs. per sq. in. After Heating.							
Cement.	Sand.									
Temperatures, Deg. F..			200°	300°	400°	500°	600°	700°	800°	900°
1 Alpha*	..	9,167	18,830	7,920	9,190	9,400	9,333	8,217	8,060	6,060
1 Alpha†	..	12,480	4,447	13,767	13,910	12,787	12,130	2,130	9,985	.....
1 Dyckerhof*	..	5,017	.....	.....	.....	.....	4,313	13,483	4,380	.....
1 Mankato*	..	1,867	1,657	1,876	1,966	1,603	1,453	1,496	1,400	1,185
1 Mankato†	..	3,873	4,043	3,523	3,810	4,133	4,133	3,957	3,900	2,990
1 Mankato*	1	538	491	432	.....	471	.....	381	.....	317
1 Mankato†	1	2,170	2,067	1,953	.....	2,063	.....	2 240	.....	1,767

*Cubes set in air. †Cubes set in water.

the surface of the concrete became flushed with water.

The investigation had three primary objects. First, to ascertain at what temperature the concrete began to lose crushing strength due to heat treatment; second, the rate at which strength decreased as a result of increase of heat, and last, but not least, the effect of varying temperature upon the elastic properties of the concrete; the purpose being to determine if the elasticity began to diminish prior to the strength or concurrently with it. It was decided to make 500 degrees Fahrenheit the initial heat, and then to increase the temperature by intervals of 250 degrees Fahernheit, to 2,250 degrees Fahrenheit, testing specimens at each temperature. The upper temperature limit was well above the average of a burning building, which is conservatively estimated by most experts as ranging from 1,500 degrees to 2,500 degrees Fahrenheit.

The determinations of crushing strengths were made upon 4-inch cubes; for the elastic properties, prisms 6x6x15 inches, were used, the height being sufficent to allow the measuring of compression on a length of 12 inches, and the cross-section being large enough to avoid the necessity of considering the specimen as a column.

To establish the quality of the concrete, three cubes and three prisms of each composition were first tested without being heated; then three cubes and two prisms of each composition were tested at each temperature.

Method of Heating.—The heating to 1,750 degrees Fahrenheit was done in an oven type of gas furnace. The furnace had a capacity of twelve cubes or two prisms and also allowed room for protecting them from the flames with fire bricks placed around the sides and top. The specimens were kept from contact with the floor by being supported on iron rods. Above 1,750 degrees Fahrenheit, the heating was done in a large gas crucible furnace.

To insure equal heating throughout the specimen, the rate of heating was arbitrarily fixed at 45 minutes to reach the first 500 degrees, and 30 minutes for each successive 250 degrees, the maximum heat being held 10 minutes before removing the specimen. This method subjected the prisms to a shorter period of heating than the cubes for every temperature except 500 degrees, because the former was brought to the required temperature, held there, and then removed. The latter were charged into the furnace 12 at a time, brought to the proper heat, held there 10 minutes, and then three cubes removed; then the temperature was raised 250 degrees, and held again. This such a poor conductor of heat that only a small portion of it ever reaches a tembeing continued until the last cubes were removed. Good results were obtained for the cubes for all temperatures, but it is doubtful if the prisms were uniformly heated at temperatures under 1,250 degrees Fahrenheit, as will be explained later.

Temperatures were measured continuously by a Le Chatelier pyrometer. The thermo-couple was located about 4 inches above the floor of the furnace and closely surrounded by specimens.

After heating, the specimens were immediately removed from the furnace and allowed to cool in the air. The testing was done at intervals up to three weeks subsequent to the heating.

Method of Testing.—The tests were made upon Riehle testing machine of 100,-

TABLE II.

Compressive Strength of 4-in. Trap-Rock Concrete Cubes.

Specimen No.	Age in Days. Before Heating.	Age in Days. Between Heat'g and Testing.	Heated to Degrees Fahrenheit.	Ultimate Strength lbs. per sq. in.	Condition After Heating.
1	32	..	Unheated	1908	
2	32	..	"	1913	
3	32	..	"	1892	
4	36	2	500	1808	
5	36	2	500	2100	
6	36	2	500	1853	
7	36	2	750	1880	
8	36	2	750	1690	Slight cracks.
9	36	2	750	1950	
10	36	2	1000	1547	Brittle and full of minute cracks.
11	36	2	1000	1273	Same.
12	36	2	1000	1418	Same.
13	36	2	1250	1110	Brittle and had several small cracks.
14	36	2	1250	1163	Same.
15	36	2	1250	1459	Same.
16	50	10	1500	1265	Few cracks; appears sound.
17	50	10	1500	1802	Sound; no cracks.
18	50	10	1500	1602	Same.
19	50	10	1750	644	Full of cracks.
20	50	10	1750	1220	Same; one crack extending entirely around.
21	50	10	1750	904	Full of cracks.
22	44	9	2000	680	Full of cracks; one extending around 3 sides.
23	44	9	2000	1072	Few cracks; surface was pitted.
24	44	9	2000	790	Same.
25	44	9	2250	458	Slightly fused on one edge; few cracks.
26	44	9	2250	628	Very much fused on bottom.
27	44	9	2250	420	Full of cracks; slightly fused on oneedge.

000 lbs. capacity. The cubes were faced on the upper surface with plaster of paris, the lower face being in all cases smooth enough to require only a few sheets of blotting paper to insure a firm bearing. The pressure was applied to the top and bottom faces as determined by their position in the mold. The pressure was applied very slowly and steadily until the specimens failed.

The prisms were faced on both ends with plaster and compressions measured on a gaged length of 12 inches, by an electric contact extensometer adjusted to the specimen. The load was applied at the same rate as for the cubes. It is important that the load should not be applied faster than the concrete will adjust itself to the new stresses, or a fictitious strength will be recorded and instrument readings will alter until an equilibrium has been established. Compressions were measured at loads of 0, 25, 50 and 100 lbs. per sq. in., and then by increments of 200 lbs. per sq. in., until indications of failure forced the removal of the instrument. Sets were measured one minute after the removal of each load, this interval being found sufficient to allow the specimen to assume a stable condition.

It was originally intended to have the concrete at least sixty days old before testing, but owing to an unavoidable delay in securing part of the material it became necessary to test the specimens when a little over a month old. This was much to the disadvantage of the concrete in the fire tests, and it also accounts for the rather low values obtained in the tests of unheated specimens.

Results.—Table II gives the ultimate crushing strength of the 4-inch trap cubes which were heated to various temperatures and crushed after cooling. No appreciable effect upon the strength can be noted until a temperature of 750 degrees is reached. This gave slightly lower average strengths. Beyond 750 degrees the decrease was marked, though there were two or three exceptions to the rule notable at 1,500 degrees, where two of the specimens gave remarkably high results. Why these cubes should have withstood the heat so much better than the others is not known. With the above exception, the surfaces of all specimens heated over 750 degrees were covered with minute cracks. At 2,250 degrees Fahrenheit the cubes were slightly fused, due to the fact that fire brick protection was displaced in removing previous specimens, and the remainder were more or less exposed to direct contact with the flames.

Table III gives similar data for the limestone cubes. The three unheated cubes show an average strength only slightly inferior to that of the trap mixture. Heating to 500 degrees, however, gave a great loss in strength. There were no evidences in the appearance of the cubes indicating this deterioration. No further weakness resulted at a temperature of 750 degrees, but beyond this the loss of strength continued. After heating to 2,000 degrees and 2,250 degrees the cubes appeared strong and in good condition while hot, but when cold they began to disintegrate. No attempt was made to test these specimens.

TABLE III.

Compressive Strength of 4-in. Limestone Concrete Cubes.

Specimen No.	Age in Days. Before Heating.	Age in Days. Between Heat'g and Testing.	Heated to Degrees Fahrenheit.	Ultimate Strength lbs. per sq. in.	Condition After Heating.
1	34	..	Un. heated	1968	
2	34	..	"	1843	
3	34	..	"	1640	
4	38	3	500	1227	Somewhat brittle.
5	38	3	500	1290	Same.
6	38	3	500	1184	Same.
7	38	3	750	1122	Brittle, and gave metalic sound if struck.
8	38	3	750	1440	Same.
9	38	3	750	1170	Same.
10	38	3	1000	923	Stone slightly calcined.
11	38	3	1000	991	Same.
12	38	3	1000	1214	Same.
13	38	3	1250	988	Calcination throughout.
14	38	3	1250	1038	Same, but appeared sound.
15	38	3	1250	903	Same, surface discolored.
16	44	3	1500	680	Same, edges chipped.
17	44	3	1500	778	Same, full of small cracks
18	44	3	1500	838	Same, crumbles easily
19	44	3	1750	832	Same, and discolored.
20	44	3	1750	684	Very fragile.
21	44	3	1750	922	
22	44	3	2000	...	Crumbled on cooling.
23	44	3	2000	...	Same.
24	44	3	2000	...	Same.
25	44	3	2250	...	Same.
26	44	3	2250	...	Same.
27	44	3	2250	...	Same.

Table IV contains the results of the tests upon the elastic properties of trap-rock prisms. Three curves were also plotted for each specimen: 1, total deformation; 2, set, and 3, true elastic limit. The latter was obtained by Professor Bach's method, viz., by subtracting from each total deformation reading the corresponding set reading. Modulus of elasticity (E) was figured for three points of the true elastic curve.

Taking the age into consideration the

values for the unheated specimens compare favorably with the results of other investigators. As is usual, the value of E diminishes with increase of pressure. With the heated specimens this is not so marked, in fact, it is often the reverse, particularly with the intermediate loading. There is, however, a very marked decrease in the value of E due to the heating. This change becomes very apparent even with a temperature of 500 degrees and the value gradually decreases with the increase of heat. There were some erratic results, but later investigation makes it quite certain they were due to imperfect heating.

After the elastic measurements on the prisms were completed the extensometer was removed and the specimen loaded to

TABLE IV.

Compressive Strength and Modulus of Elasticity of Trap-rock Concrete Prisms.

Specimen No.	Age in Days. Before Heating.	Between Heat'g and Testing.	Heated to	Ultimate Strength in lbs. per sq. in.	Elasticity at 200 lbs. per sq. in.	Elasticity at 200 lbs. per sq. in.	Elasticity at 1,000 lbs. per sq. in.	Condition After Heating.	Specimen No.
2	33	..	.....	1,560	3,450,000	2,140,000	1,700,000	Specimen in good condition.....	2
3	33	..	.....	1.820	3,180,000	3,000,000	2,440,000	Same.....	3
4	34	..	..	1,725	3,340,000	2,070,000	1,610,000	Same.....	4
10A	48	6	500°F.	1,404	715,000	902,000	863,000	Same.....	10A
11A	48	6	500°	1,970	834,000	950,000	1,040,000	Same.....	11A
12B	49	3	750°	1,250	490,000	526,000	472,000	Very minute cracks apparent....	12B
13B	49	3	750°	835	400,000	461,000	.....	Appeared sound, but brittle	13B
16C	50	5	1,000°	735	128,000	171,500	.....	Same, had a metallic ring when struck.....	16C
17C	50	5	1,000°	1,100	160,000	212,000	.....	Same.....	17C
20D	54	3	1,250°	910	89,000	122,000	.....	Surface covered with small cracks	20D
21D	54	3	1,250°	1,055	83,000	125,000	.....	Same.....	21D
24E	56	9	1,500°	250	19,400	.....	.....	Very bad specimen, sides warped and shattered.....	24E
25E	56	9	1,500°	.....	.....	.....	.....	Worse than 24E.....	25E

failure. The ultimate crushing strengths which are thus obtained are given.

Table V gives the same data for limestone prisms. The moduli for the unheated specimens are about the same as those obtained by the writer on a series of similar tests recorded in *Engineering News* on June 1, 1905, the average value of E obtained there being approximately 3,600,000 for a sand-limestone concrete 55 to 58 days old, and the average here found being 3,300,000 for prisms 20 days younger of like composition.

The value of E falls rapidly with increase of heat applied, the same as for the trap-rock mixture.

The surfaces of the prisms of both mixtures were covered with minute cracks after being subjected to over 750 degrees and then cooled. These cracks increased in number and size as the heat

ing up of the numerous fire cracks previously mentioned.

A peculiar characteristic of many set curves for both mixtures is the tendency they have to reverse direction and go back towards the axis. No satisfactory explanation for this behavior has been suggested.

It will be noted that the elasticity of the specimens decreased rapidly with the increase of heat.

The gradual decrease in strength of both cubes and prisms due to heat treatment is shown by the curves. In general, the trap-rock mixtures were the stronger. There were some irregularities, which undoubtedly resulted from defective heating.

As stated in the early part of this paper, the length of time a specimen should remain in the furnace to bring it to a

TABLE V.

Compressive Strength and Modulus of Elasticity of Limestone Concrete Prisms.

Specimen No.	Age in Days. Before Heating.	Age in Days. Betw'n Heating and Testing.	Heated to Degrees F.	Ultimate Strength in lbs. per sq. in.	E at 300 lbs. per sq. in.	E at 600 lbs. per sq. in.	E at 1,000 lbs. per sq. in.	Condition after Heating.	Specimen No.
5...	30	....	.....	1,427	3,000 000	1,715,000	1,028,000	.....	5
6...	30	....	.....	1,452	3,340,000	2,330,000	2,080,000	.....	6
7...	30	....	.....	1,246	2,500,000	1,715,000	1,390,000	.....	7
8A.	44	4	500°	1,568	700,000	352,000	476,000	Specimen in good condition....	8A
9A.	44	4	500°	1,207	1,330,000	1,176,000	972,000	Same.....	9A
14B..	45	7	750°	1,110	500,000	333,000	344,000	Not smooth on sides.....	14B
15B..	45	7	750°	1,214	222,000	294,000	286,000	Good condition.....	15B
18C.	51	4	1,000°	932	157,000	200,000	.....	Stone on edge slightly calcined	18C
19C.	51	4	1,000°	1,145	172,000	285,000	.....	Same.....	19C
22D.	57	3	1,250°	840	92,500	13,650	.....	Stone entirely calcined to depth of 2-in.	22D
23D.	57	3	1,250°	740	59,000	10,000	.....	Same.....	23D
24E.	57	19	1,500°	.....	.....	.....	.....	Stone entirely calcined, sides warped and shattered.....	24E
25E.	57	19	1,500°	810	83,300	133,000	.....	Same as 24E to lesser degree...	25E

certain heat was fixed beforehand, and with the 4-inch cubes the rate of heating employed appeared to give them uniform treatment throughout.

It was supposed the prisms would heat uniformly also in the time allowed, but subsequent results raised doubts regarding this. However, owing to the delays previously mentioned it was now too late in the season to duplicate the specimens and get them tested before this spring, so the tests were completed and this report is rendered upon the data obtained.

Table VI gives the actual times of heating for each class of specimen. It is known now that the time allowed for the prisms was not nearly sufficient to insure uniform temperature throughout. This is particularly true for the low temperatures. With the high temperatures the variation was probably not so great.

A test was recently made of the conductivity of the concrete in the prisms under the conditions of heating employed in the tests, and it was found that by allowing 1 hour 15 minutes to bring the furnace temperature up to 750 degrees Fahrenheit, and then holding that temperature constant, it required 2 hours 40 minutes more for the interior of two different prisms to attain the same temperature. Then raising the furnace temperature to 1,000 degrees in 30 minutes, it required 1 hour 10 minutes more for the prisms to become uniformly heated throughout. The tests were made by imbedding thermo-couples in the middle of the prisms, and connecting them by switch to the same galvanometer on which the couple in the furnace was recording. The concrete on which this test was made was 28 days old. In this instance it required 5 hours 35 minutes to obtain a temperature of 1,000 degrees Fahrenheit, through 3 inches of concrete where the specimen was surrounded by heat on all sides, with no radiation possible.

This last experiment proved that the concrete had a very low conductivity and made certain the fact that the prisms tested had not been heated throughout to the temperature with which they are credited. At the same time, the writer believes, it explains the apparent discrep-

TABLE VI.

Period of Heating the Test Specimens.

Specimen.		Heated to Degrees F.	Time.
4-in. cubes	.....	500°	55 minutes
"	.....	750°	1 hr., 35 min.
"	.....	1,000°	2 " 15 "
"	.....	1,250°	2 " 55 "
"	.....	1,500°	2 " 55 "
"	.....	1,750°	3 " 35 "
"	.....	2,000°	3 " 55 "
"	.....	2,250°	4 " 35 "
Prisms	.....	500°	55 minutes
"	.....	750°	1 hr., 25 min.
"	.....	1,000°	1 " 55 "
"	.....	1,250°	2 " 25 "
"	.....	1,500°	2 " 55 "

ancy which exists between the results of these tests and some very satisfactory fire tests which have been made upon full-sized floor constructions. In a test of the latter character the fire is applied to one side only, and, although a heat of 1,700 degrees to 2,000 degrees is maintained for four hours, the concrete is perature which would cause it to deteriorate to any great extent.

The writer is fully aware that the data presented are very incomplete and by no means sufficient upon which to base conclusions. The problem is an extremely

difficult one, and at the same time very important. He plans to continue the investigation as opportunity offers and hopes that other investigators will give it their attention so that in the near future some really reliable data may be obtained.

The investigation of this subject, together with the experiments detailed in this paper, was undertaken at the request of the Joint Committees on Concrete and Reinforced Concrete of this society, and forms part of the broad inquiry into the properties of that material which is being conducted in the various testing laboratories and technical schools of the country, under the general supervision of that committee.

The actual work of the investigation, together with the calculations and plotting of the curves, was done under directions of the writer by Messrs. F. H. Burch, Jr., and W. H. Connell, Jr., two students in the department of mechanical engineering at Columbia University, and formed the subject of a research thesis problem in their senior year. Much credit is due these men for their faithful devotion to their work, and their energy in performing the tedious details. The presentation of this paper at this time was made possible only by their conscientious assistance.

Standard Specifications for Cement.

Following is the report of the committee on standard specifications for cement of the American Society for Testing Materials, and shows the solid basis upon which the specifications adopted by this society last year now rest:

The standard specifications for cement, which were reported by your committee at the last annual meeting, were formally adopted by the society by letter ballot November 14, 1904.

The interval which has since elapsed is not considered by your committee to be of sufficient length for a thorough trial of the specifications, and it has been decided to postpone the consideration of any changes in the specifications for the present.

Believing that the steps which led to the final adoption of the standard specifications for cement are, and will be, of increasing interest, the committee presents the following statement as a matter of record:

With the rapid development of the cement industry the attainment of a standard of specifications has been most earnestly sought.

The report of the committee on January 7, 1885, of the American Society of Civil Engineers was the first step in this country in this direction; the report, however, within a very few years became too elastic and indefinite to serve the purpose.

In 1896, at the suggestion of Mr. Richard L. Humphrey, a series of editorials appeared in the *Engineering Record*, calling attention to the inadequacy of the 1885 rules and urging the appointment of a new committee to revise them.

Following this a resolution was presented by Mr. Edward P. North, at a meeting of the American Society of Civil Engineers, held November 4, 1896, requesting the board of direction to report on the advisability of appointing a committee to report on "The Proper Manipulation of the Tests of Cement."

The board reported at the annual meeting of the society on January 20, 1897, and was instructed to issue a letter ballot. This vote was canvassed, and on July 1, 1897, the board appointed the committee, consisting of Messrs. George F. Swain, Alfred Noble, George S. Webster, W. B. W. Howe, L. C. Sabin, O. M. Carter and H. M. York. The two members last named subsequently resigned.

This committee organized, with Prof. George F. Swain as chairman and Mr. H. M. York as secretary. A circular was prepared and widely distributed, and at the annual meeting in January, 1900, a progress report was presented, giving a summary of the answers received.

At the annual meeting, held on January 16, 1901, the committee was authorized to increase its membership to nine, and in accordance therewith appointed Messrs. Spencer B. Newberry, Clifford Richardson, Richard L. Humphrey and F. H. Lewis.

This committee organized by the election of Prof. George F. Swain, chairman, and Mr. Richard L. Humphrey, secretary. On the retirement of Prof. Swain from the chairmanship, under the pressure of personal affairs, Mr. George S. Webster was elected in his place.

The committee presented to the society a progress report on uniform tests of cement on January 21, 1903.

Efforts were made in 1901 by the American members of the various committees on cement of the International Association for Testing Materials to secure international co-operation in the adoption of a standard specification for cement. This effort came to naught because there were no uniform methods for testing cement and because, also, of the inability to agree on such methods.

On June 6, 1901, the board of engineer officers, U. S. A., appointed by the authority of the secretary of war, presented a report on testing hydraulic cements, and to which were appended standard speci-

fications for both natural and Portland cements.

At the annual meeting of the American Society for Testing Materials, held on June 15, 1902, the executive committee was authorized to appoint a committee to report on standard specifications for cement, and in accordance therewith named Messrs. Robert W. Lesley, Booth, Garrett & Blair, A. W. Dow, Edward M. Hagar, Richard L. Humphrey, Lathbury & Spackman, Andreas Lundteigen, Charles F. McKenna, W. W. Maclay, Spencer B. Newberry, J. M. Porter, Clifford Richardson and George F. Swain, with power to increase its membership, subject to the approval of the executive committe.

The committee assembled at the call of Robert W. Lesley, member of the executive committee and temporary chairman, on October 31, 1902, and organized by the election of Prof. George F. Swain, chairman; Mr. George S. Webster, vice-chairman, and Mr. Richard L. Humphrey, secretary.

The committee increased its number by the addition of the following members: Messrs. T. J. Brady, C. W. Boynton, Spencer Cosby, L. Henry Dumary, A. F. Gerstell, William H. Harding, F. H. Lewis, John B. Lober, Charles A. Matcham, Alfred Noble, H. W. Parkhurst, Joseph T. Richards, L. C. Sabin, H. J. Seaman, S. S. Voorhees, W. J. Wilgus, George S. Webster, H. G. Kelly, vice-president American Railway Engineering and Maintenance of Way Association, and W. S. Eames, president American Institute of Architects.

Messrs. F. H. Bainbridge, Alfred Noble, H. W. Parkhurst and W. J. Wilgus subsequently resigned from the committee.

The committee postponed further action pending the report of the committee on uniform tests of cement of the American Society of Civil Engineers.

On February 4, 1903, the committee adopted as a basis for its work the report of the committee on uniform tests of cement.

In order to obtain data to aid in drafting a standard specifications and to test the value of the methods recommended, the committee sent four samples of natural and five samples of Portland cement to some thirty prominent laboratories engaged in testing cement, with the request that they be tested in accordance with these methods.

The results of these tests were collated, and in accordance with the instructions of the committee a tentative specification was prepared by the secretary, Mr. Richard L. Humphrey. These were considered on December 3, 1903, amended and approved March 29, 1904, and adopted by the committee by letter ballot June 11, 1904; these specifications were approved by the American Society for Testing Materials at its annual meeting June 17, 1904, and adopted by letter ballot of the society November 14, 1904.

On December 9, 1902, the Association of American Portland Cement Manufacturers appointed a committee on standard specifications for cement, consisting of Messrs. W. W. Maclay, A. F. Gerstell, D. Millen, B. S. Dunn, T. M. Righter. This committee was succeeded on January 12, 1904, by the appointment of Messrs. W. W. Maclay, chairman; A. F. Gerstell, W. H. Harding, S. B. Newberry, Charles A. Matcham, H. J. Seaman and Charles F. Wade. The latter committee recommended these specifications for the above association, and they were adopted on June 16, 1904.

The committee on masonry of the American Railway Engineering and Maintenance Way Association presented a specification for Portland and natural cement, which was adopted by that association at the annual convention, held March 19, 1903, and recommended as a provisional standard specification. At the convention held in March, 1904, no further action was taken in view of the association having been requested to send a representative to serve on the committee on standard specifications for cement. Upon the recommendation of the same committee the association, in place of the provisional specificatiqns above referred to, adopted these standard specifications on March 21, 1905.

These reports on uniform tests of cement and standard specifications for cement are the result of over six years' labor of a thoroughly representative body of experts, covering every field from the manufacturer to the consumer.

The various committees are still in existence and will from time to time recommend such changes as are to be found by experience to be desirable, thus gradually perfecting the specifications as a whole.

In the meantime, by the adoption of these specifications a standard of excellence is set, which will enable the manufacturer to concentrate his efforts in operating his plant so as to produce uniformly the grade of cement required and at a minimum cost to the consumer.

Respectfully submitted on behalf of the committee,

GEORGE F. SWAIN, Chairman,
GEORGE S. WEBSTER, Vice-Chairman,
RICHARD L. HUMPHREY, Secretary.

Concrete Building Blocks.

The following extracts are made from a paper by George E. Walsh, in a recent number of *Insurance Engineering*. Many of our readers will not agree with

some of his statements regarding sand and methods of manipulation and test, and they are invited to reply, giving the results of their practical experience:

In the endeavor to keep his concrete blocks for building purposes up to a high standard, the manufacturer or builder who makes his own blocks must pay special attention to sampling and testing. The wide difference in the durable qualities of concrete blocks can be attributed only to the nature of the ingredients used in their manufacture, the proportions of the materials and the manner of mixing, compressing and curing. The very fact that concrete is a manufactured and not a natural product is responsible for its variation unless rigidly tested and sampled. For the sake of his own reputation a manufacturer or builder should exert himself to study carefully technical features of the work to ascertain so far as possible absolute formulas for making the best concrete building blocks and for the elimination of all errors or variations from certain well-defined standards.

The quality of the cement employed is all important, and the character of the concrete blocks is largely determined by the grade of the chief ingredients in their composition. Even the best Portland cement shows variation in the proportions of silica, alumina, iron oxide and lime, but trouble in the use of cement for concrete blocks is not due so much to the faulty character of the cement as to the result of imperfect preparation of the raw materials. In fact, 7 per cent. of impurities, such as magnesia and sulphuric anhydride, can be considered harmless, but defective preparation of the raw materials causes endless difficulties to the manufacturer of building blocks. The cement that is over-burned or under-burned will produce endless trouble. The ideal cement for this purpose should be finely ground and thoroughly burned. Samples should be tested in particular to see if the cement shows a tendency to ball up when moistened, and also in respect to its freedom from coarse particles.

The coarse particles of Portland cement are practically inert, and they show little adhesive quality when moistened and mixed with finely-sieved sand for the manufacture of concrete blocks. In this respect the manufacturer can not be too careful in taking his samples from different barrels to determine the relative fineness of the lot. Other things being equal, the finer the cement is pulverized the better will the results prove. It not only proves more adhesive in cementing the mass together, but it is easier worked and manipulated in the machines. In testing the cement and sand for concrete blocks, sieves of brass wire, twilled and not woven, should be used, with the meshes spaced from 100 to 200 to the linear inch. Hand sieving is better than machine sieving. For sampling purposes the cement should be dried before it is placed in the sieves. The residue retained on the fine sieves should determine the relative fineness of the cement supplied.

In using sand for mixing with the cement similar careful testing should precede actual manufacture. Uniformity of the concrete mixture must be secured. Natural sands properly proportioned and reduced to uniform size for proper mixture with the cement will tend to make the concrete building blocks firm and durable. A good deal of carelessness is noted in this work among those not skilled in the manufacture of concrete blocks. Once screening through a sieve with a relatively small mesh is often considered sufficient. Instead of that, the sand should be placed in a sieve with 20 meshes to the linear inch, and only such particles which pass through these holes should be considered fine enough for the purpose. A second sieve with 30 meshes to the linear inch should be placed under the first to receive the screened sand. Only such particles as are retained on this sieve are useful. The finer sand which passes through the meshes should be rejected. In this way only do we secure uniformity of results. The sand is neither too coarse nor too fine, and all that is used after this screening can be depended upon to yield similar results when mixed with the cement. Coarse particles of sand in the concrete are no worse than too powdery particles, and one should be avoided as much as the other. In a good many of the faulty building blocks of concrete used today the trouble can be traced directly to the unequal grades of sand. The uniformity of the sand is more important than its actual composition, and as this is something that every manufacturer and builder can remedy there is no excuse for its lack.

The mixing of the cement and sand, which have both been tested by such mechanical means as described, always insures uniform results provided the proper percentage of water is used, and the mixing machines are kept free from clogging due to the "balling up" of the cement in them. The skilled cement worker performs his task often without formula. He can not specify the amount of water used to reduce the cement to a proper consistency. It is a part of the testing work of the manufacturer to find out

the exact amount of water required to reduce the mixture to a paste most satisfactory for his work. The normal consistency of the paste or mixture when moistened is an indefinite condition unless tested by mechanical means. By means of the Vicat Needle apparatus it is possible to knead the paste until it is of uniform consistency, and then by measuring the amount of water used and the proportions of cement and sand a formula can be worked out. In all subsequent operations the exact proportions of water, sand and cement should be used, provided that the tests of all ingredients have been made and found to come up to the standard. The mass should be rather wet than too dry, for variations in the amount of compression in molding will be less where the paste is comparatively thin.

The importance of producing sample briquettes to determine the best results is unquestioned. A score of such samples may not yield the desired results, but eventually the experiments will bring out a satisfactory formula. In each experiment every step in the process must be carefully jotted down. A slight deviation in the formula may throw out all the work. Cement working can not be successfully carried on by guesswork, but in the sudden popularity of concrete blocks for building purposes there is the danger that many will undertake the work who are not properly skilled in manipulating the materials. With less careful attention to the details, the quality of the blocks must prove inferior, and lacking uniformity of strength and durable qualities their use in walls may prove disastrous. The walls of a large building which are designed to carry heavy loads must possess uniform strength throughout, and one course of inferior concrete blocks might shift the load and cause a general collapse.

The setting of the concrete is a factor that is somewhat debatable. Quick setting of the concrete may be desirable from some points of view, but certainly not if it is in any way weakening to the subsequent strength and resisting qualities of the blocks. Some anxious builders who make their own blocks seek quick-setting or hardening mixtures rather than slow-drying compounds. Too often the question of durability and strength is overlooked. There is a happy medium between the very slow and too rapid hardening of concrete blocks, but it is better to err on the side of the former than the latter. The mixing of natural cements and slag cements to hasten the hardening process is quite common among some builders, but their methods are open to serious doubts. The action of frost on natural cements used for the construction of concrete building blocks may tend to crack and seriously injure the walls of a building.

The time required for the "initial set" should be noted in making sample tests, and also the time required for the hard or "final set." In many instances the former is overlooked, while in reality it is more important than the latter. When the process of hardening or setting first begins, crystallization commences, and and any disturbance whatever of the blocks at this period weakens them. Moreover, it is absolutely necessary that all mixing, molding and manipulation of all kinds should be finished before the "initial set" begins. Otherwise the blocks can not have the proper strength accredited to them. The "initial set" should therefore not begin too early in the stage of mixing, or the whole process is rendered worthless. By testing samples it is possible to ascertain with a fair degree of certainty the average time required for a given mixture to begin its initial set, and in this way avoid any trouble caused by too early hardening. The samples should be placed in moist air, and frequent tests should be made with weighted wires of given diameters. The degree of penetration of these wires indicates the changes which take place in the concrete after mixture. The only absolutely infallible rule is to use the Vicat Needle, which determines accurately the exact degree of hardening at any moment of the process.

The "final set" is a matter that can be determined without so much attention to details. As the concrete properly mixed sets only sufficiently at the end of seven days to reach 50 per cent. of its full strength, its use should not be thought of for building purposes until after a week. Up to this time the blocks pass through a process of change which makes it quite desirable that they should not be moved from the drying shed or curing place. After that they can be handled with a tolerable degree of safety, and they may even be employed for light work; but factories which have storage facilities where the blocks can be kept indefinitely for months should prove to the satisfaction of builders that time in setting of the concrete is worth money to them. In buildings where many courses are to be used, and where the load factor on the walls is great, the concrete blocks that have been allowed six months or more to harden are worth more than those only thirty days or less of age. The concrete continues to harden upward of a year after being molded in blocks,

but it is doubtful if the blocks gain much in strength after six months. According to the tests made in blocks, the concrete reaches nearly its maximum of strength at the end of six or seven months. A little depends upon the nature of the cement and the mixing process, but on the average the blocks reach 90 to 97 per cent. of their total strength after six months of drying.

There are needed today in the trade certain improvements in mixing machines which will eliminate some of the uncertainties of manipulation. One of these is a device to prevent "balling up" in the machine. This is quite common in making concrete, and it is impossible to prevent it entirely. The uniform fineness of the cement and sand will tend to reduce the trouble and also the amount of water used is a distinct factor in the operation. But for all that "balling up" will happen in the best mixing machines, and this prevents working into a homogeneous mass. The result of this is faulty blocks, with here and there spots which show weakness. Where the mass lacks uniformity of mixture there is sure to be some defect in the proper adhesiveness between cement and sand. A machine that would eliminate this trouble would prove of great advantage to the trade.

Another improvement that is needed is a machine or device which will indicate automatically when the mixing is complete without stopping the machine. Owing to the danger of too early hardening precious time may be lost by stopping the machine to ascertain if the mixing is complete. In this respect some sort of device should be invented to show the actual consistency of the mass while the machine is in operation. Such an improvement would greatly simplify matters and make the manufacturer of concrete building blocks surer of his methods. It would also serve to prevent heavy losses that must now occur through improper mixing of the mass.

The final improvement that might be suggested is a self-cleaning machine. At present the difficulty of keeping the mixing machine clean offers many disadvantages. The check upon the process of manufacture by this sometimes represents a considerable amount of loss. This can not be avoided under present conditions, but it is hoped that makers of the machines will shortly discover some improvement in this direction. The mixing and molding machines have been vastly improved and developed in the last few years, and it is a narrow view of the subject to imagine that they have today reached the limit of improvement. With more practical working with the machines new points of improvement may be suggested, and the manufacture of concrete building blocks may become a more exact science each year. There is no question about the ultimate value and importance to the building trade of these concrete blocks and briquettes, and everything that will tend to improve them should be done.

Concrete Covering Preferred for Water Main in Sea Water.

A cement or concrete coat is proposed for the 30-inch water main which runs from the Absecon pumping station to Atlantic City. The main was constructed about three or four years ago. It was guaranteed to remain in perfect condition for a period of five years. The action of chemical salts and substances which form the meadow land, the salt water and the atmospheric conditions showed a tendency to reduce the life of the steel main. In order to prevent the reduction of the life of the material and to avoid the expense of constructing a new main, the concrete covering is proposed.

LEAGUE OF AMERICAN MUNICIPALITIES

The Convention—St. Louis Municipal Lighting—Asphalt Construction and Maintenance.

The Convention.

The ninth annual convention of the League of American Municipalities was called to order by President W. C. Crolius, mayor of Joliet, Ill., at 10:33 a. m., Wednesday, August 23, in Memorial Hall, Toledo, Ohio, who delivered his annual address, after a welcome had been extended to the convention by Mayor Robert H. Finch, of Toledo.

The report of the secretary showed a number of additions to the membership of the league. His financial report showed receipts of $2,470.45 and disbursements, including his salary of $1,800, of $2,348.63. The balance in the treasurer's hands last year was increased to $283.37. This does not include any expense for publishing the monthly bulletin of the league, which is expected to pay its own way. It was decided that the secretary should hereafter manage and edit the bulletin under authority of the league, but on his own responsibility, and to take all money accruing from its sale in excess of $2,400.

Papers were read by Charles A. Hague on "Fire Department Water Supply," and by James W. Wood on "St. Louis' Municipal Lighting," abstracts from which are printed herewith. Mayor Silas Cook, of East St. Louis, Ill., discussed "Street Cleaning," advocating the block system in the business districts, assigning three or four blocks to each street man, in the belief that their rivalry will tend to keep the streets in the best condition. Mayor Cook is an advocate of street flushing and of receptacles at street corners for waste papers and other refuse which citizens usually throw in the street.

During the afternoon the delegates enjoyed a ride around the Perrysburg and Maumee belt road.

At the evening session Peter Witt, city clerk of Cleveland, gave an address on "How to Tax Real Estate," which was extemporaneous and illustrated with stereopticon views in his inimitable fashion. R. P. King's paper on "Abatement of the Smoke Nuisance," to appear later, was also on the program, but was read by title, owing to his indisposition.

On account of non-arrival of speakers the program for Thursday was changed. Judge Oscar Leser's paper on "What the Great Fire Accomplished for Baltimore" was read. It was received too late for this number. Andrew Rosewater's paper on "Factors in Asphalt Paving Construction, Maintenance and Cost," which is given herewith in full, was read and gave rise to some discussion.

Mayor Edward F. Dunne, of Chicago, was added to the program and spoke on "Municipal Ownership of Public Utilities." This gave rise to some rather acrimonious discussion, some of the delegates failing to confine themselves to the merits of the question and resorting to personalities and political references. Mayor Dunne's paper outlined briefly the success of English cities in municipal ownership, and naturally referred in particular to municipal ownership and operation of street car lines. He referred to the history of Chicago's municipal water works and electric light plants, showed the troubles with the present street railway system, and gave a statement of the various steps that have been taken toward municipal ownership. Some idea was also given of his plans for continuing the fight for municipal ownership of the Chicago street railways.

Vice Mayor Jones, of Columbus, Ohio, also gave an address on the same subject.

The address of L. G. Powers, on "Municipal Accountin," was also delivered. It will appear in this magazine later.

Alderman La Pointe, of Montreal, representing the Union of Canadian Municipalities, made a short address. W. S. Crandall read a paper on "A Standard for Disinfectants."

The evening was spent at one of Toledo's summer evening resorts.

At the session on Friday morning officers were elected as follows:

G. H. Rhett, Mayor of Charleston, S. C., President.

Henry Bohl, Columbus, Ohio, First Vice President.

Joseph E. McCafferty, Councilman, Wilmington, Del., Second Vice President.

Geo. F. Hine, Mayor of Poughkeepsie, N. Y., Third Vice President.

F. S. Spence, Toronto, Can., Fourth Vice President.

Louis A. Betz, Comptroller of St. Paul, Minn.; M. A. Brouse, Mayor of Kokomo, Ind.; Silas Cook, Mayor of East St. Louis, Ill.; Robert H. Finch, Mayor of Toledo, Ohio; Hugo Grosser, Chief Statistician of Chicago, Ill.; Harry F. Hooper, City Registrar of Baltimore, Md., and Otto Rhinehart, President of City Council of Detroit, Mich., Directors.

Chicago, St. Louis, Cleveland, East St. Louis, Ill., Wilmington, Del., Duluth, Minn., Kokomo, Ind., Baltimore, Md., St. Paul, Minn., Charleston, S. C., Georgetown, S. C., Poughkeepsie, N. Y., Omaha, Neb., Columbus, O., Racine, Wis., Zanesville, Springfield, Akron, Hamilton, Salem and Fostoria, O., Orange, N. J., Terre Haute, Ind., Macon, Ga., Des Moines, Ia., Toronto, Can., and Detroit, Mich., were among the cities represented by from one to twenty-six delegates.

St. Louis Municipal Lighting.

By JOSEPH W. WOOD, C. E., St. Louis, Mo.

The city of St. Louis was one of the first cities to adopt electricity to light her streets and alleys. The streets of the entire city were lighted with 2,000 candle power arc lamps, swinging over the cross streets from 60, 70 and 80 foot poles. The alleys are lighted with 32 candle power incandescent lamps. This contract took effect in 1890 and was for a period of ten years, and the cost per arc lamp per year was $74.95. This system was a failure in the residence portion of the city, due largely to the height of the lamps above the streets, the lamps being able to cast their rays over only a small portion of the territory to be illuminated.

In 1899 the city let a new contract, which took effect in 1900. The central or business portion of the city is now lighted by arc lamps. The distribution of the lamps is much closer and better than under the former contract. The lamps are hung from neat ornamental iron poles, about 20 feet from the walk, and are of the enclosed 2,000 candle power type, and cost the city in round figures $98 per lamp per year. The residence and outlying districts are lighted with Welsbach gas lamps of 60 candle power, and cost the city per lamp per year $28 in one section, and $24.45 in the other section.

These lighting contracts just mentioned are supposed to have cost the lighting companies $47,000 to pass the city council and house of delegates. Mr. Folk landed most of the boodlers in the penitentiary, and as a reward the people of Missouri made him governor of the state.

It is my opinion that the city of St. Louis should not at this time pay more than $75 per electric lamp per year, for her lighting to a private company, though she is now paying $98; and especially so when the city lawmakers have granted the lighting companies permission to do commercial lighting and pre-empt and occupy without compensation our public highways, deny the right of competition to others, deny the right of a property owner to cross an alley or street overhead or underground that he may light a building from his own lighting plant on the opposite side of the street or alley.

In 1901 the city of St. Louis was paying the lighting companies 13 cents per kw. for current for lighting its public buildings. The party elected in the spring of 1901 was pledged to municipal ownership of public utilities; the first and most inviting field was the lighting of public buildings, and the first act of the administration was to pass an ordinance and appropriate the money to erect two electric plants to take in groups of buildings, one to be erected at the city hall, to light the new city hall, the old city hall, Four Courts and jail, court house and No. 6 engine house. Each of these groups of buildings occupies a whole block to itself, except the fire engine house. The other plant was to take care of the insane asylum, female hospital and poor house, all of which are large buildings. This ordinance was passed in June, 1901, and the lighting contract with the lighting companies expired in September of the following year. The lighting companies immediately threatened to refuse to make any temporary contract or extend the time beyond the life of their contract, which was made from year to year. The time being too short to erect the plant, the mayor vetoed the ordinance.

On the following September, when the bids were opened for lighting the public buildings, the city was surprised at receiving a bid for 6 1-4 cents per kw. of current, a drop from 13 cents. For the time being this knocked the life out of the proposition to instal a plant. One year later, however, bids for the same work were raised to 7 1-2 cents, and I presume that we would soon have had the old rate back, but the mayor and the

board of public improvements, anticipating a rise in the rate as long as the city was helpless, accepted the bid of 7 1-2 cents, and at once framed an ordinance to install the plants, which was duly passed and the plants installed as originally intended at both the city hall and at the insane asylum. I shall speak more particularly of the city hall plant, because it being larger and being in the city hall, I was able to watch it more closely and direct its management. While not a large plant, in the common sense of the word, the people looked upon it as redeeming party pledges and also the entering wedge in the campaign for municipal ownership.

It was my good fortune, by direction of the board of public improvements, and especially its president, Mr. Hiram Phillips, to install a complete plant, and I believe successfully operate this plant, and after two full years I have demonstrated to the people of St. Louis that, while we paid to the lighting companies in 1901, 13 cents per kw. hour, we have made the same current for two years at an average of 1.56 cents per kw. hour and for the past six months the cost per kw. hour has been less than one cent.

The generating plant consists of three 128-horsepower, simple non-condensing engines, and to each engine are two direct connected electric generators, one of the alternating current type and the other of the direct current type. This system of two generators, producing two different currents, is an unusual combination. Both generators produce current at 220 volts. The alternating generator is excited by the direct current generator. This alternating current is then transformed up to 2,200 volts and conducted through the streets for about a mile and then reduced to 110 volts for use in lighting the various buildings already noted. The current from the direct generators is used to light the city hall and run the elevators and motors in that building. The plant being divided into three units it is thus very flexible. Two engines carry the maximum load. One engine is always reserved for repairs or emergencies, and in this manner the operating expenses are reduced to the most economical point. The installation of about 100 horsepower in motors in the city hall necessitated installing the fourth unit last summer, a direct current 75 kw. 220 volt outfit. This unit can be used for power alone, or can assist in the lighting of the city hall.

The completed plant, as it is now in operation, cost the city $40,000. This does not include the boilers and feed pumps, but includes $5,000 worth of electrical conduits in the streets to carry the current to the buildings at a distance from the plant. This plant is not an extravagant one in finish or detail, nor was it purchased at a job lot sale, but if you will pardon me for expressing my personal pride, I will say that this plant is modern, complete in every detail, thoroughly practical and the operation has proved it to be economical.

This plant is a continuous running plant in its operation. It is operated on the eight-hour basis.

There are three engineers, one receiving $150 per month, and two $90 each per month. The firemen receive $60 per month; dynamo and coal passers receive $50, and coal is $2 per ton. You will note from the salary list that the plant is not operated upon the penny plan. The help receives fair wages, and as a result we are able to secure good help and have no accidents or repair bills to eat up our profits.

Our system of checking up is as complete as it is possible to make it, and to this system we owe our success. Every building has its recording watt meter; the boilers have their water meter; every pound of coal is weighed at the building; every pound of ash is weighed; each engineer (every eight hours) is required to read all meters and record the work of his watch on data sheets provided. He also signs this report. These daily report sheets are filed with the chief engineer, and from them is compiled the monthly report showing the output and expense account.

An engineer's log book is kept, in which each engineer records the number of hours each generator, pump, boiler or any part of the plant is in service; the amount of oil, waste or packing that is used. Provision is made for recording any special work done, cleaning or accidents. We know the date we pack an engine or pump; how long the packing lasted. In other words, we have a complete record of the operation of the plant, no guess work on anything. Some will probably say that this is too much bookkeeping and takes too much time. Such is not the case. Our log books and data sheets are arranged and printed to suit the conditions, and ten minutes' time on each will suffice to record all the data. Every employe of the plant has access to these records, and as a result he is stimulated in his work. For instance, we have a recording steam gauge which records the steam pressure in the boilers every minute of the day. Firemen are not allowed to vary their steam pressure more than five pounds. The first thing a fireman does on coming on

watch is to read the record of his predecessor; the result is that an even steam pressure is maintained in the boilers at all times, and you all know that this is a saving of fuel.

The record shows that the plant has paid the original investment of $40,000 and $3,988.07 for interest and depreciation in twenty-three months, with a balance of $1,310 on hand on the first day of June, 1905.

Our system of arriving at these results is shown in the following totals for the twenty-three months:

Entire total expense of operating plant	$33,429.45
Part of expense charged to light plant	10,327.54
Interest and depreciation, 10 per cent. on $40,000	3,988.07
Total of expense, interest and depreciation	$14,360.71
Cost of current at contract price with light company	55,670.81
Net earnings	$41,310.10
Output of plant in kw. hours	891,573

Division of expenses based upon actual operation:

Cost of heating and ventilating	65.5 p c
Cost of hot water and house supply	2.0 p c
Cost of elevator maintenance	1.5 p c
Cost of electric energy	31.0 p c
Total	100 p c

The high percentage for heating and ventilating is due to the fact that the blast or fan system is used. While the most sanitary form of heating it is the most expensive system. Prior to July, 1903, the steam plant was only used for heating and ventilating the building. In 1901-2 the total expense for operating the plant was $12,730.23. In 1902-3 the total expense was $11,022.29.

The average for these two years it will be seen is $11,876.26. In July, 1903, the new electric light plant began operations, and from July 31, 1903, to July 31, 1904, the entire total expense of heating the building (as heretofore) and operating the electric light plant was $17,192.03.

Now, if we deduct from this amount the average cost per year for heating before the light plant was installed, which is $11,876.26, we have a balance of $5,315.77, which represents the total extra cost of operating the light plant.

Now we do not arrive at these results by charging the plant with 13 cents per kw., the price paid the lighting companies at the time the plant was authorized to be installed, but we accepted the competitive rate established by the lighting companies, which at the time the plant was ready to operate was cut to 7 1-2 cents, and in September, 1904, was further cut to 5 cents, and against these prices we have paid for our plant in twenty-three months. Many of you would say that at these prices you should not install a municipal plant, but with these low rates you can see what can be accomplished.

There are only two things the lighting companies can say against our proposition, that is, that we charge nothing for our building rent, the plant being in the basement, and we pay no water rent. Our water rent would not exceed $10 per month, and the basement of our building could be used for no other purpose. I do not believe any municipality should throw away any natural advantages it possesses, or charge itself with high rents for space, when these same spaces could not, in the very nature of things, bring a high rent from private parties.

There is one important reason why many franchise-holding companies can not charge less than they do; because, first, the promoter must have about 25 per cent. of the stock for promoting, and without investing anything. Next, the bonds are sold at a discount of from 25 to 50 per cent. Then the stock must be watered for 10 per cent. The municipality sells its bonds at par, oftentimes receiving a premium for them. It can buy in the open market as cheap as or cheaper than private consumers. The result is, that the municipality has the goods for every dollar it has invested. As for the technical knowledge required to install or operate a municipal improvement of any kind, the city has the same opportunity of employing such help that corporations have.

The stock argument against municipal ownership has always been dishonesty and corruption in political affairs. There is no more dishonesty or graft in political life today than there is in a corporation or private doings. In political affairs you have an ever watchful press to expose and often time magnify the evils thereof. They have not the same opportunity to expose graft and corruption in private affairs, and it does not often become public. Public utilities can be owned and operated by the municipalities under political conditions with just as great a degree of success as under private ownership. What we need today is the American Dunne of Chicago, Tom Johnson of Cleveland, or a Hiram Phillips of St. Louis, to meet and overcome conditions as they now exist.

St. Louis owns and operates its water works system under political conditions, and there is no better or more successful system in the country. Since the es-

tablishment of the city hall plant, the city has installed three other light and power plants; one at the water works, which furnishes light and power to three stations, located within a distance of seven miles, and operates a street railway, connecting the stations. The current has been generated for 1-2 cent per kw. The other two plants are located at the insane asylum and at the new city hospital, to consist of fourteen buildings when completed. They are also operated with success.

My personal experience in the employment of help, especially in mechanical pursuits, would be to establish a sound civil service system, requiring a new examination every two or four years. At the same time I do not hesitate to say that with all our political evils we have a class of help employed, in part by political recommendations, as honest, faithful and loyal as any private interests could secure. Of course, much depends upon the head of the department. In my department I tell every man employed to read certain fixed rules posted in the plant, and if he can not abide by every rule not to go to work. He is further given to understand that while politics may assist him in securing a position, politics would not hold his position if he did not attend strictly to his duties.

Factors in Asphalt Paving Construction, Maintenance and Cost.

By ANDREW ROSEWATER, C. E., Omaha, Neb.

The first asphalt pavement in the world was laid in the city of Paris about fifty-one years ago. About six million square yards, or about three hundred miles of European streets, are now paved with that material.

Twenty-five years ago about twelve miles, or less than one-fifth of one per cent. of the paved streets of the cities of the United States were paved with asphalt. Today about twenty-five hundred miles of streets in the United States, embracing an area approximating forty-four million square yards, are paved with asphalt. This represents in first cost an investment of $100,000,000, and including the cost of repairs and resurfacing, a total outlay of not less than $150,000,000.

Independent of the materials used for resurfacing and maintenance, the materials comprising the asphalt pavements of the cities of the United States would fill over one million cars, enough to make a train six thousand miles long, extending from New York to San Francisco and back, aggregating twenty-two million tons, divided about as follows:

Stone	11,462,000 tons
Sand	7,568,000 tons
Cement	1,386,000 tons
Stone dust	726,000 tons
Asphalt	726,000 tons
Oil	132,000 tons

Classifying by percentages, the materials comprising an asphalt pavement of six inch concrete base, one and one-half inch binder, and two inches of asphalt topping, as usually laid, will run approximately, as follows: Stone, 52.1 per cent.; sand, 34.4 per cent.; cement, 6.3 per cent.; stone dust, 3.3 per cent.; asphalt, 3.3 per cent.. and oil, 0.6 per cent. Thus, it will be seen that asphalt covers not to exceed 3.3 per cent. of the materials of an American asphalt pavement, and ranges as low as 1.8 per cent., when asphalts rich in bitumen are used. Fully 90 per cent. of the American asphalt pavements may be termed artificial bituminous sandstone, the wearing surface being 90 per cent. sand and 10 per cent. bituminous mastic.

The European asphalts, until within a few years ago, were all made from the crushed powder of a natural limestone, of which 90 per cent. is very finely ground limestone, and 10 per cent. is bituminous mastic. These asphalts were compact, but very slippery,—the gradients upon which they can be used being limited in consequence. This, in the early literature upon asphalt pavements, gave rise to the statement that they could not be used upon greater than 2 per cent. grades. Experience has demonstrated that the American asphalt pavements are practical for any traffic upon grades up to 5 per cent., and with short sections at intervals upon grades very much steeper, in fact, as steep as 12 per cent.

Until within a few years the wearing capacity of an asphalt pavement was considered so limited as to confine its use to parks and light traffic streets. Pavements laid in European cities, notably in Paris, by an American company in 1886, based upon the sand and bituminous composite, failed completely to meet the dense traffic encountered, and within six months after being laid, the remnants were ordered removed.

Within the past ten years successful asphalt pavements have been laid by the same American company in London, Glasgow and Paris, and the granite pavements of several New York city streets have been successfully and satisfactorily displaced with American asphalt pavements.

Up to 1893, asphalt paving specifications within the cities of the United

States were practically closed to the use of all asphalts but one, that coming from one portion of Trinidad Island, on the South American coast. From 1881 to 1893 the price of asphalt pavements, with 6-inch base and 2 1-2-inch topping, notwithstanding material reductions in cost of materials and labor, remained constant at about $3 per square yard, with a five years' guarantee. The quality of pavements was not uniform, the same contractor very often laid a good pavement on one street and a very poor one on an adjoining street, under the same specifications. Much mystification was indulged in and only the trade was accredited with possession of the secrets of a good asphalt pavement. The engineers of our cities, in view of their limited knowledge of the subject, in preparing specifications, placed dependence mainly upon the guaranteed period of maintenance, allowing each bidder to prepare his own formula for proportioning and preparing mixture. Inspection, to a great extent, on the asphalt portion of the pavement was a farce. Few cities maintained a laboratory, and where laboratories were maintained the requisities of a successful pavement were unknown, or misunderstood.

The question as to the influence of the sub-base, the construction of the concrete, the nature of the sand, extent of filler in the sand voids, the amount and nature of bitumen, kind of oil for fluxing, were all partly understood and seldom were results similarly obtainable, except by mere accident of chance. Believing that better progress could be made and lower prices obtained by opening the specifications for asphalt pavements to competition, the author of this article, in 1893, prepared specifications for the city of Omaha, admitting all asphalts under the usual bond and guarantee provisions. To succeed in such an effort it became necessary to induce Washington, New York, Chicago, Denver and other cities to co-operate. This was done and proved successful. All sorts of litigation followed. Each attempt of those early in the field was met with costly and stubborn resistance; but the opposition to open specifications proved futile, and ultimately developed a field for asphalts from the mines of California, Utah, Kentucky, Venezuela and other localities, in addition to those of Trinidad. The prices, as a result of bitter competition for a time, became ruinous to all concerned. The cost of paving dropped, in 1895 and 1897, in many localities fully 60 per cent. The scarcity of expert knowledge brought with this competition some very poor as well as very good pavements. But the public was the ultimate winner, from the more general knowledge gained and the more thorough investigation on the part of all in their endeavor to develop a pavement that would excel others in quality and durability. The outcome is not only better pavements from the Trinidad product, as shown by the success in the congested traffic streets of New York, Paris, London and other cities; but also a keener knowledge of the whole subject, and good pavements are now made from artificial asphalts produced from residuums of the California oils, and also from asphalts from Venezuela, Cuba and numerous other sources.

The engineering profession has, in the past decade, also been admitted into the secret sanctuaries of the laboratories, and has discovered that, aside from the shape of the streets and the asphalt used, the sand, which constitutes 90 per cent of the surface covering, exerts very much influence upon the result. Numerous analyses of poor pavements have shown that it was not always wise to let the bidders make specifications, and that many important requisites should be provided for in the specifications. In place of 6 and 7 per cent. of bitumen in the asphalt mixtures frequently found in poor pavements of our cities, it has been demonstrated that good pavements should have at least 10 per cent. of bitumen. This applies equally to bituminous limestone pavements as to bituminous sandstone pavements. Careful study of the materials, systems of construction, etc., requisites further shows that the more compact any pavement is the better its wearing qualities, so it is found essential that to secure the minimum of voids in the sand the grains should be so graded as to admit of packing and finally, after this, the further addition of fine powdered filler will make the mass still more compact. Stone dust has been and is largely used for this purpose, but in larger quantities than in years past, and as an improvement, finely ground Portland cement is being substituted in place of the stone dust. This has been used, with evidently very excellent results, on the Fifth avenue pavements in New York and those of London, and the same filler was used on Sixteenth street, the leading thoroughfare of Omaha, and is required in all pavements now laid in that city, to an extent of not less than 5 per cent., and 12 per cent. will probably be required in the specifications hereafter. The difference in cost of a few cents per yard will not justify its exclusion on economical grounds.

With these facts bearing on the history

of its development and relative to the materials needed in asphalt pavements in view, the factors which enter into the construction of an asphalt pavement, its maintenance and cost can more readily be comprehended. In this class, as in all other pavements, the first essential to good, durable construction is a proper base. A good earth road requires first of all, proper drainage, both for surface and sub-surface. The solution of this feature is a simple engineering proposition. The next essential is consolidation—the more compact, the less will the surface yield to vehicle traffic, and the greater is its durability. The fact that earth yields readily to the softening and dissolving influence of water demands a very high crown upon an earth road that it may shed water as fast as possible to escape its softening agency. The fact that it partly dissolves when wet makes a soil yield more readily wnen porous because these voids will quickly absorb, or fill with the dissolving agent, hence, the more compacted and less porous, the less it will be exposed to moistening influences.

Again, if the earth roadbed is subjected to water from beneath the surface, it will not only be undergoing constant change in the summer period, but when winter comes, the water, when freezing, will expand and heave up the surface. With these fundamental principles outlined, we next come to the pavement proper.

Divested of all verbiage, a pavement is a veneering, or wearing road surface. It is placed there to protect the base and give it durability. The early attempts at pavements were of the old Roman road order, consisting of layers of large blocks of stone in mortar, which distributed the load over a much wider area than that directly exposed to the tires of the wheels. These roads have numerous variations, such as slabs of granite laid in parallel rows for the wheels to run on; tram railways, with iron or steel surfaces distributing their loads through the medium of ties or planks to the earth surface; the macadam roads developed about one hundred years ago, with depths of broken stone, varying with the traffic, and depending for their efficiency upon compacting the aggregates, first on the traffic, which took years, and, later, upon great road-rolling machinery, which crushed and forced the various aggregates to a wedged and compact mass, developing a smooth surface.

It was contended, even by railway builders, that roadbeds should have a certain elasticity to be practical. It is now clearly demonstrated that the firmer and more unyielding the foundation, the more durable it will be. The toughest steel, bent back and forth by continuous vibrations, will break. Rock foundations, yielding to compression impacts, will ultimately crush the particles, and the greater and more numerous the voids, the quicker the change of shape and final destruction. The theory of the need of elastic foundations is erroneous; the elastic requisites should be in the spring of the carriages and rolling stock, and not the roadbed. The construction of the so-called bitulithic pavement, which is really a macadam with a bituminous binder, recognizes the need of reducing voids by grading the aggregates so as to reduce the voids from forty to below twenty per cent., and finally fill this twenty per cent. with tar or other bituminous binder.

In the construction of macadam pavements it is conceded that next to the earth road, the need of a large crown is imperative. Why? For the same reason as in the case of an earth road: to shed water so as to minimize its destructive effect. Experience has demonstrated that, all things considered, the most economic covering for road purposes upon soil capable of immediate consolidation into monolith form is a concrete of sand, cement and stone. Unlike the old Roman road, this can be made more uniform, with less material and skilled labor, by the use of small broken stone, which, with various grades of sizes and the mortar of sand and cement, produces a compact and uniform mass.

The more ready action of the elements upon what is known as natural cement makes the so-called Portland cement preferable for exposed concrete work. Its great cost, until within the past few years, has barred its use largely in our paving works. Since, however, its cost has been largely reduced by the increase of its manufacture in this country, its advantages for paving are recognized and its use is becoming more general.

Concrete as outlined could be made for country roads and pavements, were it not that the broken limestone soon wears smooth, and, like the European asphalts, becomes too slippery. For this reason, thus far, it is used as an intermediate layer to distribute the wheel load to the earth. Whenever the upper three or four inches can be economically made into a composite of cement and sand, with provisions to resist the forces of expansion and contraction, we will have a sandstone monolith pavement able to continuously resist the action of water, and yet furnish a footing which never can become slippery. Until then, a composite cover-

ing of sand with bituminous cementing material known as asphalt will be used.

The factors of a good asphalt pavement are:

(1) A good sub-drained compacted base.

(2) An intermediate monolithic material, preferably Portland cement concrete, to rest upon and transmit the load uniformly to the earth below.

(3) An asphalt covering of wearing capacity capable to meet all traffic conditions and to resist the destructive agencies of extreme temperatures and other climatic influences.

To meet requisite No. 3 we are confronted with such varied and conflicting opinions that it becomes necessary to carefully analyze all pros and cons and impartially accept and reject what is good and bad out of them. First of all, let us consider the governing elements.

First—The asphalt covering must be compact and hard enough at all times to meet traffic requirements.

Second—It must not be readily affected by water.

Third—It must be durable.

Fourth—It must retain its smooth form and not become wavy.

Fifth—It must not be slippery.

In order that requirement No. 1 be met, the component elements of the covering must be such as to become a solid, voidless mass that can resist compression of traffic and expansion and contraction of temperature extremes.

Experience has shown that asphalts from Trinidad, Venezuela, California and numerous other sections of the country, sixty per cent. of whose bitumens are soluble in boiling naphtha, possess sufficient adhesive cementing qualities to make a proper paving cement. Experience has further developed that the actual and necessary quantity of bitumen thus soluble to make a proper paving mixture shall range between the extremes of ten and thirteen per cent. by weight. The exact proportion will vary between these figures, dependent upon the nature of the sand grains and voids in the sand. The specifications should, to insure good results, provide that not less than ten per cent. of bitumen shall be required in the mixture. This does not mean ten per cent. of asphalt, for what is known as refined asphalt varies in the degree of refinement. Bermudez, Venezuela or California asphalts are, when refined or manufactured, free from sand or other mineral mixtures, and, therefore, contain from ninety-five to ninety-nine per cent. pure bitumen. The Trinidad asphalt, as refined, contains fine, impalpable mineral powder to the extent of thirty-six per cent. In the latter case it requires more asphalt to produce the ten per cent. of bitumen, but, on the other hand, the amount of filler of stone dust or Portland cement required with this asphalt is proportionally less than with the others.

The common method of comparing asphalts according to their alleged purity, based upon the bitumen they contain, is both erroneous and calculated to deceive. It is attempted by so-called anti-trust contractors versus the so-called trust contractors. As a matter of fact, the quantity of bitumen in the commercial asphalt product is simply a commercial question which is governed by freight and other factors. Pavement mixtures, laid with an asphalt containing 90 per cent. bitumen in its commercial form, are no better nor worse than mixtures from an asphalt containing 5 per cent., as in each case 10 per cent. of extracted bitumen of a specified quality is required and used in the mixture. In the Manhattan borough of New York, and a few other cities of the country, the specifications for asphalt pavement exclude asphalt, which, in its commercial form, contains less than 90 per cent. bitumen. Such specifications do not protect the public against poor pavements, but increase their cost by excluding competition. As an illustration I need but to cite a case recently in the court at Lincoln, Neb., where, to exclude the use of Trinidad asphalt in the interest of a certain competitor of the company handling that material, the specifications were so drawn as to prohibit the use of any asphalt in the proposed pavements which in its commercial form had less than 90 per cent. bitumen.

The testimony of Chief Inspector Dow, of Washington, in this case was that this clause did not insure good asphalt, for its provisions would exclude Cuban asphalt, which produced among the very best, if not the best, asphalt pavements laid in Washington. His testimony showed that Cuban asphalt contained only 70 per cent. bitumen in its commercial form. Whilst it is well for cities to guard against trusts or any form of combinations, the fact that asphalt has been and could readily be bought in the open market from numerous sources for several years past disposes of the trust question, and the anti-trust cry, so vehemently indulged in by some in relation to asphalt, like the cry of "wolf," should be cautiously listened to by municipal authorities.

In evidence of the delusive representations as to asphalt trusts, the author of this article had occasion, during the year

1904, to visit the cities of Winnipeg, Man., and Detroit, Mich., two cities which own their own plants, and found that asphalts of every brand were obtainable. The city of Omaha, which is now operating its own repair plant, advertised for bids last spring, and received proposals from California, Bermudez and Trinidad pitch lake asphalt dealers, at prices ranging from $19 to $26 per ton.

In view of these facts, it is clear that municipal interests are best subserved by providing specifications calling for open competition as to asphalts and asphalts of requisite quality can best be obtained by providing for the minimum of bitumen in their mixtures subject to the boiling naptha test, which determines the malthene or petrolene components which constitute the cementing quality of asphaltic bitumen.

Another feature of considerable comment upon which opinions are as varied as there are interests, is the claim of susceptibility of certain asphalts to the effects of moisture and which, for that apparent reason, are used as a basis to exclude asphalts and thereby favor certain contractors and punish others. From practical contact with the varied features of this question, I am led to regard specification provisions placing power in boards or officers of boards to discriminate on grounds of the above nature, as far more dangerous to the honest public service than any possible short-coming affecting longevity of pavements from such alleged effects. The asphalt pavement does not exist which can withstand continued exposure under water without deterioration. Asphalt pavements, when under water a length of time, become more or less soft and the great deterioration resulting from water upon asphalt pavements is the action of wheels and horses' hoofs upon the softened surface. Sand-stones when wetted and exposed to abrasive forces, act like grindstones wearing away rapidly as the grinding goes on whilst being subjected to moisture. This is equally the case with the bituminous sand-stone. Chief Inspector Dow of Washington, who is, perhaps, the ablest exponent and originator of the dangerous clause giving preference to asphalts not readily affected by water, informed the author of this article last summer, when extending him many courtesies on an inspection tour of Washington pavements, that for the past seven years all gutters on asphalt paved streets in the Capital City had been paved with vitrified brick. Mr. Dow must have concluded that all asphalts deteriorate more rapidly when subjected to water influences and had little faith in the theory that certain asphalts were not readily affected by water, or he would not have urged the exclusion from use of asphalts alleged to be affected and then studiously avoided using those of preferred merit in gutters where they would be exposed to moisture influence.

Having disposed of the asphaltic features of the mixture, the equally and possibly more important mixture factor is the sand, which comprises, approximately, 90 per cent. of the asphalt covering. To bring forcibly to mind the sand factor, I need but cite you to a discussion at the recent International Congress of Engineers, of the relative value of stones for macadam. One of the speakers, referring to sand-stones, said that it should not be forgotten that there are extreme differences in the quality of sand-stones. No one who has observed sand-stone from various quarries and localities can fail to be impressed with the truth of this statement. Yet few stop to think that sand-stones are composed of grains of various grades of sand. That being the case, is it not evident that an asphalt paved surface, an artificial sand-stone monolith covering, is as apt to vary in its qualities, owing to different gradings of sand, as the natural sand-stone itself? Extended observations on this subject have clearly shown that to produce the best wearing mixtures, sand of certain various graded grains gives better results than other sands.

The problem of how to determine and secure the sand that will grade best, and at the same time prove the toughest and most adaptable to resist wear like the natural sand-stone of the best quality, is still only partially solved. Independent of the sand and asphalt, I have already outlined the need of a suitable filler. My information as to the use of Portland cement for this purpose in place of the natural dust of carbonate of lime, was obtained from an interview with Mr. Clifford Richardson, who is, doubtless, the greatest living expert on asphalt pavements, taken in their entirety. His work, entitled "The Modern Asphalt Pavement," which has since appeared, refers to the good results of a Portland cement filler, but disclaims an understanding of the reason why.

Having now outlined the general problems and factors of asphalt paving construction, I will briefly outline the factors of maintenance and cost.

The history of municipal growth has shown it impossible to avoid constant cutting up and otherwise disturbing the paved surfaces of urban streets. Water works construction, sewer construction, gas construction and telegraph, electric

light, telephone and other conduits of every kind are brought into demand with each new discovery and each new construction, and the problem of finding a pavement that is permanent is as unsolvable as the "squaring of the circle."

The only feature of permanency existing in public works is that of permanency of repairs. In connection with asphalts, as well as other pavements, the economic lines are along those of prompt attention to the repairs before the cuts are enlarged by traffic. Twenty years of close observation of municipal conditions leads me to the conclusion that every city should have a plant and an organized corps of skilled men to attend to the maintenance and repair of its paved streets. Once equipped with the best of modern appliances, streets can be kept in a condition of continuous repairs at the minimum cost. To do this the construction and engineering departments must be divorced from partisan politics and placed under a permanent system of civil service.

In the short period of asphalt repairs, conducted under the writer's supervision this year, sufficient figures have been obtained to warrant the belief that at least 25 per cent. can be saved to the municipality by ownership of its own repair plant, and certainly 50 per cent. more comfort can be gained thereby and still a greater per cent. of damage to vehicles avoided, not to speak of persons hurt. The same experience briefly developed at Omaha is reported by Mr. Proctor, the expert in charge of the Detroit plant, which has been in operation over one year.

We now come to the factors governing the cost of asphalt pavements.

The approximate relative cost of the various elements in an asphalt pavement, barring legal or other unnecessary avoidable expense, may be considered distributed about as follows:

Excavation and preparing earth road surface.....	7 per cent.
Concrete base	38 per cent.
Binder 1 1-2 in. thick.....	14 per cent.
Asphalt topping, 1 1-2 in. thick	29 per cent.
Plant use	5 per cent.
Superintendence and miscellaneous	3 per cent.
Contingencies	4 per cent.
	100 per cent.

Independent of these percentages of cost, two important factors materially affect the cost of asphalt paving.

First—The legal provisions for the work.

Second—The directness of all provisions in specifications.

With reference to the legal provisions, every contractor, to avoid uncertainty and risk in undertaking work, should be insured that every necessary step required by law to be taken should be clearly set out in the laws and ordinances and properly followed. Every step taken by the contractor through uncertainty as to these provisions is necessarily charged for to justify the risk. The cities of the country invariably pay dearly when their lawmakers, through incompetency or purposely, make ambiguous laws affecting public improvements.

The second factor, viz.: proper specifications, is equally as important as the first. If an engineer or board of public improvements make a two-sided specification whereby uncertainty exists as to the intent or future interpretation of any provision, the contractor feels exposed to the possibility of its operating against him by what is known as a "hold-up" process and he makes provision in his bid accordingly. It is a very common thing to see provisions in asphalt specifications purposely, or through ignorance, so worded as to enable the municipal officials to exercise power in such manner as to make or break a contractor with seemingly good cause. Every specification to bring about the best results for the city, both as to good work and also economic prices should designate unequivocally everything to be done and how it is to be done, and not, as is often worded, "as the engineer or board may determine." There is no excuse for half of the vague terms in ordinary specifications and wherever they exist the municipality must ultimately pay for the faulty features. It is the business of the specifications to define every possible requisite directly, both as to kind, quality and extent of the materials required and how they shall be applied; and prices should be called for upon a specified basis for all extras that may possibly enter into the work. Every proposal should be based upon a designated list of materials as to quantity which should form the basis of determining the lowest bidder, so as to remove the possibility of fraud, or the suspicion that fraud may be practiced. Every contractor at the same time should understand that he will be required to perform what he agrees to do under his contract. With honest specifications only can the cities look for honest and economical work.

A last and not least important factor is the provision for payment. If a contractor must receive tax certificates and collect his pay from them, or some other bills payable, upon which there hangs an uncertainty as to time of payment, he will invariably charge enough more for the cost of such risk and collection. The

best and economic method is to provide for cash payment by the city, which is better able to raise money at low rates of bonded issue, or by some equally good method. Such provision will be a material factor in reducing cost of paving.

In concluding, by way of supplying an omission under the head of maintenance, I deem it proper to add a suggestion relative to the durability of an asphalt pavement. It has been shown that water deteriorates all asphalts if continuously allowed to stand upon them. Asphalt pavements are practically impervious to water—the slightest depressions of even one-twentieth of an inch will hold moisture which to the eye makes the pavement frequently appear as full of holes. The water upon asphalt streets will rapidly evaporate if simply the result of a rain or a periodical flushing, but the drenching of asphalt paved surfaces by continued hourly sprinkling leaves the surface constantly moist, and as a result, subject to rapid wear from traffic erosion. Asphalt streets should be swept and not sprinkled, if they are to be economically used.

MUNICIPAL PROBLEMS

Municipal Ownership Commission—New Public Service Department in Grand Rapids—Electric Pumping Plant—Passaic River Pollution—Washington Filter Plant—Morris Gas Co.—Indianapolis Paving Case—South Omaha Paving Case—Iowa Public Improvements—Grade Crossings—Bitulithic Contracts—Hull's Municipal Gas Plant.

Commission to Investigate Municipal Ownership.

The executive council of the National Civic Federation, at the request of its departments of industrial economies and of trade agreements, has decided to appoint a commission to make a thorough investigation in this country and Europe of national and municipal ownership and operation of public utilities. In a statement on the subject of the aims and scope of the commission, issued August 6, the executive council of the Civic Federation says:

The scope of this inquiry will cover the relative advantages of public ownership and operation, as compared with public ownership and private operation and private ownership and operation. Each system will be examined with regard to its effect upon, among other things, wages, hours and conditions of labor, collective, bargaining, cost and character of service, political conditions, civil service, spoils system and municipal corruption, financial results and taxation.

Among the members of the commission are the following: Melville E. Ingalls, Isaac N. Seligman, Oscar S. Straus, Albert Shaw, Alexander H. Revell, Robert W. DeForest, Frederick N. Judson, Austen G. Fox, Frank A. Vanderlip, John Mitchell, Samuel Gompers, E. E. Clark, James Duncan, John F. Tobin, Timothy Healy, F. J. McNulty, Prof. Edwin R. A. Seligman, Prof. J. W. Jenks and Carroll D. Wright.

Many labor men, it is said, have begun to look at both sides of the question, since the agitation over municipal ownership has become acute, and they realize that national and municipal ownership and operation of public utilities involve the operation of the civil service system. Under the civil service laws no discrimination may be used in employing union or non-union men.

New Public Service Department in Grand Rapids.

The city of Grand Rapids, Michigan, has recently organized a public service department, combining the lighting plant, water works, street work, etc., under the management of one man, instead of several boards, with a superintendent for each department, who is accountable to no one but the board of works. The city, after two disastrous floods, is preparing elaborate plans for flood protection, which involve the expenditure of nearly a half million dollars. The question of water supply is also still under consideration, and the city has received several propositions providing for a supply, ranging from Lake Michigan, 30 miles away, at a cost of $2,000,000, to Grand river and a filtering plant in the city.

Electric Pumping Plants at Schenectaday, N. Y.

The water supply for Schenectady, N. Y., is now furnished by an electric pumping plant at Rotterdam, three miles distant, rated at 24,000,000 gallons against a head of 110 pounds.

"Worthington" 18-inch, two-stage, vertical shaft turbines are used. Each consists of an outer casing, inside which is a set of fixed diffusion rings and vanes, and an impeller. The water enters the top of the casing at the center of the impeller and is thrown out through the diffusion vanes into the discharge chamber. The vanes are so curved as to transform the kinetic energy, imparted to the water by the pump, into static pressure with minimum loss. The pumps are installed in the 21-foot pit of the station, and draw the water through a 42-inch suction pipe from two circular wells 42 and 35 feet deep and 50 feet in diameter. These wells are near the electric pumping station building and are covered by a reinforced concrete structure. They have 3-foot concrete walls, and gravel bottoms up through which the water filters.

The vertical shafts of the two main pumps extend to the station floor and are direct coupled to the rotors of two 800-h.p., 550-volt, 40-cycle, three-phase "General Electric" squirrel cage induction motors, installed on the station floor. The rated speed of the motors is 800 r.p.m., and their lubrication, a very important matter at such high speed, is effected by forcing oil at a pressure of about 100 pounds under the thrust bearing, which is arranged in the horizontal bearing shield on top of the motor. For supplying the oil, two vertical triple "Knowles" oil pumps, each direct driven by a geared 3-h.p. induction motor, are provided. Since the main pumps are located above the normal water level of the wells, a two-cylinder, 9x7-inch vacuum pump, direct driven by a 5-h.p. induction motor, is installed on the station floor and used to produce a vacuum in the suction pipe so as to draw the water to the pumps when starting up. A drainage pump of the "Worthington" one-stage vertical volute type is installed in the pit. Its vertical shaft extends like that of the main pumps to the station floor, and it is driven at 1,200 r.p.m. by a direct-connected, 5-h.p., three-phase induction motor installed near the priming pump. All of the motors are supplied with 550-volt, 40-cycle, three-phase current, and have squirrel cage rotors.

Two separate and independent 10,000-volt transmission lines are provided, running from a sub-station of the Schenectady Illuminating Company, which furnishes the city of Schenectady with power and receives its current from the water power stations in Mechanicsville and Spiers Falls. The lines are also connected to the power stations of the General Electric Works, as a further source of power. The lines are controlled at both ends by General Electric automatic oil switches, and protected at both ends by General Electric lightning arresters. The oil switches are so adjusted that a heavy overload of the pump motors will trip the switches at the pumping station end of the line only, so that the pump service can be resumed immediately by closing these switches. On the other hand, a dangerous overload, or a short circuit on the line, will trip the generating station switches also, thus protecting line and apparatus against injury.

At the pumping station the high tension current is stepped down to 550 volts by two banks of three 250-kw. single-phase air blast transformers. The transformer secondaries are provided with taps, wired to double-throw switches, for starting the 800-h.p. main pump motors at quarter and half voltage in order to avoid the heavy rush of current that would be caused if the motors were started at full voltage. There is also installed a 150-kw. lighting transformer which supplies current to the village and the railway station nearby. The necessary air blast is supplied by two independent induction motor-driven blowers installed on the station floor.

A fireproof partition separates the roomy compartment containing the bus-bars and all of the high tension apparatus—lightning arresters, disconnecting switches, oil switches, transformers, etc.—from the motor room, and the entrance from one to the other is closed by fireproof doors. Imbedded in and forming part of the partition is a switchboard, containing two incoming line panels, two high tension transformer panels, and two low tension main motor panels, equipped with the necessary ammeters, volt-meters, low tension lever switches for controlling the main pump motors, and handles for the remote control of the high tension oil switches which are installed in fireproof brick cells. On these panels are also installed the lever switches controlling the auxiliary motors and the vacuum and water-pressure gauges.

The electrical layout is designed to cooperate with the use of the two independent supply lines in preventing any possibility of a total shutdown of the entire plant, upon the continuous operation of

city of Schenectady. Two sets of low tension buses are provided, and the double-throw switches enable either of the two banks of transformers to be switched on to either one of the two sets of bus-bars. The main and auxiliary switches are also double-throw, to facilitate switching over from one bus to the other.

The old steam plant, consisting of two vertical pumps, had a daily capacity of 12,000,000 gallons.—*Insurance Engineering.*

Morris, Ill., Gas Company's Affairs.

The Morris Gas Company was released from the supervision of the federal courts August 2, by an order of Judge Bethea. The assets of the company will now go into the possession of Lauren H. Turner, who purchased the concern at a sale held some time ago by Master in Chancery Sherman. The company's plant is at Morris, Ill. Bankruptcy proceedings were begun against the company in August, 1894, and James H. Pettit was appointed receiver. He operated the plant until his discharge by Judge Bethea. In his report Receiver Pettit declared that from the time of his appointment until July 31, 1901, he sold 15,282,000 cubic feet of gas and received therefor $25,589.66.

Opening of Washington's Filter Plant.

The new filtration plant just completed at Washington, D. C., was placed in operation August 15, by turning water into the first of twenty-nine beds, each having a capacity of 3,000,000 gallons. About twenty-five of these beds will be in constant use when the plant is in full operation. The water has to be run into the plant very slowly, requiring twenty-four hours for the passing of the necessary amount without disturbing the distribution of the sand, and another twenty-four hours must elapse before the filtering becomes thoroughly effective. As soon as the first bed was ready the water from it was carried into a second from the bottom, and when the second one was ready, which required another forty-eight hours for completion, a third was filled, this being accomplished on the morning of August 21. The supply from the third bed was then turned into the city mains, and each second day from August 21, another 3,000,000 gallons of pure water will be supplied to the city, displacing a like quantity of unfiltered water in the total daily consumption. A number of beds having the sand and gravel in them have not the pipe connections and other details completed yet, but it is estimated that one bed every other day will be about the rate at which they may be opened with the speediest practicable construction.

Passaic River Pollution Again Under Discussion.

Plans are being formulated by Mayor Doremus and the Board of Trade of Newark, N. J., to call a conference of representatives of several municipalities interested in the purification of the Passaic river, for the purpose of securing a united action towards cleansing the river. The decision of the court declaring the pollution act unconstitutional led to the proposed concerted action on the part of the municipalities.

Difference of Opinion of Judges on Indianapolis Paving Case.

The appellate court reversed, August 1, the decision of Judge Leathers in the case of John Monaghan vs. the City of Indianapolis, in which he decided that the specifications for a street pavement could legally call for a patented pavement if a majority of the resident property owners demanded it. In reversing the case the court can not be said to have done more than to decide that an injunction against making the patented pavement at the expense of the abutting property owners ought to be issued. Judge Comstock wrote an opinion declaring that there can be no free, competitive bidding for the work of laying a patented pavement, because the patent itself gives a monopoly. Judge Roby prepared a separate opinion substantially to the same effect. Judges Black and Robinson filed a third opinion giving other grounds and saying that they concurred in the reversal of the judgment. Judge Wiley wrote a dissenting opinion, stating that, since two-thirds of the abutting property owners had asked for the patented pavement the city authorities had a right to name it in the specifications. Judge Myers separately dissented, but no two of the six judges agreed on a statement of the law to be applied in similar cases. It is expected that the case will be appealed from the appellate court to the supreme court.

Mayor Must Sign South Omaha Paving Contract.

Judge Estelle, of the district court, issued an order recently compelling Mayor Koutsky and City Clerk Gillin, of South Omaha, Neb., to sign the contract made with Hugh Murphy, in February, 1905, for paving Missouri avenue. At the time

bids for paving the streets were advertised Hugh Murphy bid $1.90 a sq. yd. for brick block and 25 cents a cu. yd. for grading. The contract was awarded to him by the council, as the lowest bidder. Mayor Koutsky refused to sign the contract, for the reason that Murphy did not specify that he would use Purington brick. The specifications did not call for Purington brick, but called for brick block of standard make. Contractor Murphy took the matter into court, and secured the order compelling the mayor to sign the contract.

Iowa Public Improvement Law Valid.

The supreme court of Iowa has rendered a decision in the water bond case of Halsey & Co., of Chicago, vs. the City of Belle Plaine. The decision decided the constitutionality of the waterworks and sewer law, and will enable that city to construct both systems. In June, 1904, the city had a special election, at which the proposition to bond the town for the purpose of building a waterworks and sewer system was carried. The purchasers of the bonds, however, raised the question of the limit of indebtedness under the law and questioned the validity of the act passed by the assembly? The district court decided in favor of the city and this decision is affirmed by the supreme court. Improvements in a score of other Iowa cities hinged upon this decision, it is claimed.

Grade Crossings on New York Central Railway.

The officials of the New York Central railway have decided upon a plan of extensive grade crossing abolishment in the suburban district near New York. Between New York city and Croton, and New York city and White Plains, two divisions of the railroad, fifty-five grade crossings will be abolished. The State Railway Commission has set dates for hearings at fifteen different towns along the Central's lines for public consideration of this general plan, as the details relate to the municipalities through which the roads pass. The New York Central is willing to pay half the expenses of the elimination of these grade crossings, the state to pay a quarter, and the municipalities the other quarter.

Bitulithic Pavement Under Construction.

In a report to its stockholders, Warren Brothers Company embodied a statement showing that the company and its licensees have under contract this year, up to August 1, 1905, paving work covering forty-nine cities and an aggregate of 1,251,332 square yards. In most of these cities such of the contracts as have not already been completed are under construction or about to be commenced. This is the largest area that the company has had under contract at this season during any year of its existence. The work that the company has under promotion, and which will probably be brought to contract within the next three months, is greater than ever before, the prospects being that the work constructed by Warren Brothers Company and its subsidiary companies during the year 1905 will reach at least one and one-half million square yards.

A statement of the paving work under contract up to August 1, 1905, is as follows:

Warren Brothers Company—Rosedale, Kans., 11,220 sq. yds.; Watertown, N. Y., 20,934; Yonkers, N. Y., 6,000; Medford, Mass., 3,455; Woonsocket, R. I., 6,200; Elyria, O., 9,500; Cohoes, N. Y., 22,243; Superior, Wis., 15,570; St. Joseph, Mo., 1,529; Boston, Mass., 32,159; Lynn, Mass., 13,000; Cincinnati, O., 15,970, Kirchner Construction Company, 8,070; Henkel & Sullivan, 47,690; total for Cincinnati, 72,330; Newark, N. J., 1,431; Somerville, Mass., 11,570; Portland, Maine, 10,429; Worcester, Mass., 6,730; Cambridge, Mass., 14,833; Suffolk, Va., 2,500; Asheville, N. C., 30,000; Waterbury, Conn., 6,300; Taunton, Mass., 10,000. Total, 251,973 sq. yds.

Central Bitulithic Paving Company—Traverse City, Mich., 11,114 sq. yds.; Milwaukee, Wis., 14,315. Total, 25,429 sq. yds.

Western Construction Company—Logansport, Ind., 22,000 sq. yds.

Standard Bitulithic Company—Mauch Chunk, Pa., 10,400 sq. yds.; Hollidaysburg, Pa., 10,000; Harrison, N. J., 6,840; Newark, N. J., 11,000. Total, 38,240 sq. yds.

Granite Bituminous Paving Company—St. Louis, Mo., 96,712 sq. yds.

William Horrabin—Iowa City, Ia., 18,522 sq. yds.

Kansas Bitulithic Company—Hutchinson, Kans., 29,480 sq. yds.; Kansas City, Mo., 53,000. Total, 82,480 sq. yds.

Warren Bituminous Paving Company—London, Ont., 17,918 sq. yds.; Toronto, Ont., 60,726; Halifax, N. S., 2,890; Ottawa, Ont., 14,000; Chatham, Ont., 5,000. Total, 90,534 sq. yds.

Warren Construction Company—Portland, Ore., 34,115 sq. yds.; Tacoma, Wash., 26,935; Walla Walla, Wash., 29,893. Total, 90,943 sq. yds.

Nebraska Bitulithic Company, 11,239 sq. yds.

Hoosier Construction Company—Indianapolis, Ind., 25,200 sq. yds.

Southern Bitulithic Company—Shreveport, La., 34,642 sq. yds.; Birmingham, Ala., 101,828; Paducah, Ky., 36,400; Nashville, Tenn., 25,000; Little Rock, Ark., 15,800; Ashland, Ky., 115,000; Atlanta, Ga., 13,000. Total, 341,670 sq. yds.

Total under contract, 1,251,332 sq. yds.

Municipal Gas Plant at Hull, England.

A recent communication from Consul Hamm, at Hull, England, described the gas plant owned and operated by that municipality.

The quantity of gas supplied was 0.08 per cent. more than the year before, and that year showed an increase of 3.25 per cent. over 1903. The coal and cannel carbonized was 456,710 tons in 1905, yielding 10,967 cubic feet of gas per ton; 458,864 in 1904, yielding 10,868 cubic feet. The number of gas consumers was 152,165 in 1905; 146,457 in 1904. The number of gas stoves and engines in 1905 was 23,862; in 1904, 17,722.

The price of gas was reduced, to ordinary consumers, from 60 to 56 cents per 1,000 cubic feet inside the city limits, and to outsiders, from 66 to 62 cents. A further reduction of 2 cents per 1,000 cubic feet was made June 24.

The cost of coal, cannel and oil per ton carbonized was $2.5770 in 1905; in 1904, $2.7130.

The gross yearly profits, 1905, were $753,949, of which $210,561 was paid in dividends, while $2,130.48, as required by act of parliament, went into a sinking fund. The net profit was $330,338.

The length of mains was a trifle over 858 miles, an increase in 1905 of 15 miles. The number of public lamps in the city is 17,361; in the suburbs, 2,078. Of those in the city limits, 5,866 have incandescent burners.

Estimates made by the experts of the city of income were $3,485,000; the actual receipts were $3,444.740. The estimated expenditures were $2,829,000; the actual, $2,690,820. The estimates of gross profits were $656,000; the actual, $755,950.

Public Buildings Needed in St. Louis.

In his annual report, covering the financial transactions and conditions of the city for the fiscal year ending April 10, 1905, Comptroller Player strongly urges the necessity for a bond issue for needed public improvements in St. Louis. An excellent group plan for the needed public buildings and designs for the poor farm have been prepared by a commission. The funds asked for would make possible the structures desired. The comptroller says:

The amount realized for purely municipal purposes under the present rate of taxation is ample to meet all of the ordinary expenses incident to maintaining the city government.

Extraordinary demands, such as costly extensions of the sewer system, the erection of necessary additions to the eleemosynary institutions, the erection of suitable public buildings for courts, jail, police department and health department purposes, can only be met by securing the large sums required through the issue of bonds. The overshadowing importance of this public work—the urgency and pressing necessity for it—has been brought to the notice of the public and the municipal assembly in almost every grand jury report submitted in the last ten years or more. The unfortunate conditions, which have existed for so many years, are not only locally well recognized, but the press of the city and of the whole country have deplored the misfortune of the city in such respects time and again. It has been carefully explained, on many occasions, that it would be unwise, if not impossible, to so increase the annual tax levy for purely municipal purposes as to provide, through a series of years, sufficient sums to undertake the work of inaugurating and competing additions to the institutions and the erection of new public buildings so badly needed.

It is true that under the amendments to the charter adopted at the special election held on October 22, 1901, the rate of taxation for municipal purposes, as limited by the charter, may be increased by the municipal assembly in order to secure revenue for erecting public buildings, when the rate for such an increase and the purpose for which it is intended, shall have been submitted to a vote of the people, and two-thirds of the voters of the city, voting at the election to be held for that purpose, shall vote therefor. But an increase in the rate of taxation to secure revenue sufficient for the erection of the needed public buildings could not be logically advocated and would not be countenanced, because, in the first place, it would subject the taxpayers to an intolerable burden and, in the second place, would not produce within a period of ten years sufficient revenue to accomplish the ends in view.

The time is fast approaching—in fact, it is already here—when the citizens of St. Louis must face the alternative of either authorizing an issue of bonds sufficient for the public improvements which have been urgently need for almost twenty years, or else supinely witness the absolute decay and disintegration of buildings now used for the jail and four courts, those occupied by the health department and dispensaries (now housed in the old city hall) and portions of the poor house and female hospital, leaving the poor, sick and insane to be cared for in state institutions at considerable expense. The enlarging of the state institutions will follow, for the reason that the city of St. Louis is insensible to the needs of paupers, the insane and others diseased and otherwise afflicted.

ORGANIZATIONS AND INDIVIDUALS

The American Society of Municipal Improvements—Civil Service Examinations—Technical Meetings—Personal Notes.

The American Society of Municipal Improvements.

This number of MUNICIPAL ENGINEERING is issued in time to urge once more attendance of the Montreal Convention of the American Society of Municipal Improvements, which will begin at 3 p. m., Tuesday, September 5.

The report of the Committee on Municipal Data and Statistics will be presented by William Fortune, chairman, and H. N. Ruttan, the city engineer of Winnipeg, will present a paper on "Methods of Keeping Municipal Records and Accounts." There will also be a paper by H. W. Wilmot, of New York, on the forms of accounting devised for Minneapolis. The report of the Committee of Municipal Franchises will be presented by James Owen, chairman.

At 8 o'clock Nelson P. Lewis will read a paper on "The Theory and Practice of Assessments for Local Improvements," to be followed by a paper on "The Legislative Functions of Greater New York," by Milo R. Maltbie; one on "Legislative Functions Under the White Charter (of New York cities) and the Practical Effects of the Latter Upon Municipal Government," by Thos. J. Neville; one on "The Trend of Park Progress," by G. A. Parker, and the report of the Committee on Review, to be made in three parts, reviewing municipal work in the Atlantic coast States, by T. Chalkley Hatton; the rest of the United States, by Chas. C. Brown, and in Canada, by N. J. Ker.

At 8 o'clock in the evening of the 6th the report of the Committee on Street Paving will be presented by C. D. Pollock, and followed by papers on "Gutters and Cross-Walks for Macadam Pavements," by W. J. Stewart; "The Organization and Conduct of a Bureau of Street Repairs for a City of 1,250,000 Population," by Edwin J. Fort; "Paving Materials, the Importance of Preliminary Tests," by J. W. Howard, and on "Effect of Water on Asphalt," "Development of the Road Roller" and "Use of Oil on Macadam Roads." There will also be papers on "Cost of Collection and Disposal of Garbage," by B. E. Briggs, and on "Garbage Disposal Plants in the United States," by H. G. Bayles, and on "Electric Lighting, with Special Reference to Underground Construction."

The morning of September 7 will be devoted to papers by the officials of Montreal.

The evening session will have "A Review of the Anti-Mosquito Campaign, with Special Reference to the Work in New Jersey," by Edward S. Rankin; "A Standard for Disinfectants," by Wm. S. Crandall; "Sanitary Engineering in the Southern States," by J. N. Hazlehurst, Mobile, Ala., and "Sewage Disposal, an Experiment and an Experience," by W. H. V. Reimer.

It will be noted that the daylight hours of September 6 and the afternoon of September 7 are given up to the inspection of the works and the beauties of the city of Montreal. There will be further opportunity of this sort on Friday and Saturday.

A special feature of this convention is the exhibition of materials and apparatus for municipal use.

The program is certainly most attractive to those really interested in municipal improvements, the time is the most satisfactory for a visit to Montreal, and the best thing to do is to take the next train after reading this for the place of meeting.

U. S. Civil Service Examinations.

The United States Civil Service Commission will hold examinations September 13 and 14, in various cities throughout the country, to secure a list of eligibles to fill a vacancy in the position of constructing engineer for sewers and water works at Manila, P. I., and other vacancies as they may occur in the Philippine service requiring similar qualifications, at salaries of $1,400 to $2,000. Examinations will be held at the same time for the positions of architectural and structural draftsmen in the quartermaster's department at large, Washington, at salaries of $1,500. Examinations will be

held October 4, 5 and 6 for mechanical draftsmen in the ordnance department at large, at salaries of $1,000 to $1,200.

Investigation of Structural Materials.

The first bulletin of the laboratories of the United States Geological Survey for testing structural materials, at St. Louis, has been issued, giving a statement of the scope of the investigations of cement mortars and concretes, to be conducted during the year beginning with last July. They include examinations of deposits, physical tests, and chemical analyses of the sand, gravel, stone, screenings, slag, cinders, etc., to be used in the experiments.

Tests of mortars made with these materials and a typical Portland cement made by thoroughly mixing several brands which pass a given specification, will be made for tensile compressive and transverse strength with various proportions of cement, in the natural state and when sieved to one size; and for porosity, permeability and yield in mortar.

Tests of concrete will be made for tensile, compressive and transverse strength with various proportions of materials and sizes of aggregates; for absorption, weight per cubic foot, modulus of elasticity in compression and tension, percentage of voids, percentage of silt, porosity, permeability, effect of vibration on hardening of concrete and on the hardened concrete, plain and reinforced, protection of metal, adhesion to metal embedded and on flat surface, effect of freezing, effect of fire on hardening concrete and on hardened concrete, yield of concrete.

Tests will be made on full size beams of various spans, sections and compositions and on building blocks as to compressive, transverse and shearing strength and absorption of water for both wet and dry mixtures and as to permeability, methods of waterproofing, firo resisting qualities, and efflorescence.

Tests will be made of reinforced concrete beams with varying percentages of round, square and flat bars in the bottom and in both bottom and top.

The circular bears the approval of the advisory board, by Charles B. Dudley, President, and Richard L. Humphrey, Secretary.

Technical Meetings.

The annual convention of the American Gas Lighting Association will be held in Milwaukee, Wis., at the Masonic Temple, October 18, 19 and 20. The organization is composed of officers of the different gas lighting companies throughout the United States, and they meet once a year for the purpose of discussing technical questions, relative to the manufacture and distribution of illuminating and fuel gas. E. G. Cowdery, of St. Louis, is president of the association.

The annual convention of the American Public Works Association, which was to have been held at Lookout Mountain August 30 and 31, has been postponed until further notice on account of the yellow fever quarantine. W. H. Flint, sec'y, Chattanooga.

The annual meeting of the American Public Health Association will be held at Boston, Mass., Sept. 25, 26, 27, 28 and 29. Dr. Charles O. Probst, sec'y.

The Central States Waterworks Association will meet in Columbus, Ohio, September 12, 13 and 14. W. A. Veach, secy., Newark, Ohio.

Personal Notes.

Senator Bonachea has been installed mayor of Havana, Cuba.

Richard T. Mannix has been appointed city engineer, at Anderson, Ind.

Alfred M. Heston was re-elected city comptroller at Atlantic City, N. J., August 14.

Hon. Nathaniel Meader, who was second mayor of Waterville, Maine, died August 15, aged 69 years.

William H. Burr, Frederic P. Stearns and John R. Freeman have been appointed consulting engineers to the board of water supply, New York city.

C. E. Douglas has been appointed city engineer, at Meadville, Pa., succeeding W. A. Jones, who resigned to accept a position with a railroad construction company.

Benjamin W. Homans and John A. Rundlett have been appointed assistant engineers on the engineering staff of the Aqueduct Commissioners of New York city.

Samuel M. Kintner, who has for several years beeen professor of electrical engineering at the Western University, has been tendered the position of associate professor of electrical engineering in the Carnegie Technical School.

John F. Cowan has been appointed president of the Aqueduct Commission, at New York city, to succeed William H. Ten Eyck, resigned. Mr. Cowan was appointed a member of the board three months ago to succeed William E. Curtis.

Joseph Herbst, who has for a number of years been assistant superintendent of the electric light plant at Wapakoneta, Ohio, has been appointed superintendent of waterworks and electric light plant at Versailles, Ohio.

O'Brian & Rhoades, Denver, Colo., have dissolved partnership, and Nelson Rhoades, Jr., will continue the business as consulting and constructing engineer. He will occupy the same offices in Denver that the company heretofore occupied. His Mexican address will be Apartado 212, Chihuahua, Mexico.

General Roy Stone died at his home in the Phenix House, Mendham, near Morristown, N. J., August 6, aged 72 years.

General Stone was prominent throughout the United States for his work in behalf of better roads, and was known as the pioneer advocate of good roads in the United States. He never lost an opportunity of doing all that lay in his power toward improving the highways of this country, after he saw the evil of bad roads during the civil war. About 1895 certain members of congress, who knew and appreciated the propaganda and personality of General Stone, brought him and his work to the attention of Secretary of Agriculture Morton, with the result that General Stone was appointed, in 1896, a special agent to investigate and report on the condition of roads in this country, in order to ascertain whether or not the matter was of sufficient moment to be made a federal concern. The result was that congress appropriated money for the creation of the division of public roads of the department of agriculture, of which General Stone was made the chief. General Stone was interred in Arlington cemetery with military honors.

MACHINERY AND TRADE

The Wadsworth Macadam.

Kentucky rock asphalt, according to the methods of the Wadsworth Stone and Paving Co., of Pittsburg, Pa., in constructing macadam pavements, is used raw, no heating being necessary. The only machine needed to construct a roadway of this material is an ordinary steam roller, the asphalt being of such a homogeneous nature that the rolling and subsequent travel over the road is sufficient to pack the roadway almost as hard and smooth as a regular asphalt pavement.

Numerous experiments in the Pittsburg yards of the Wadsworth Stone & Paving Company show that the proper way to use this material is as follows: Shape and roll the dirt bed thoroughly as if a regular macadam or asphalt pavement were to be constructed. Next, place and roll a 6-inch layer of good crushed stone, about 2-inch size. Then spread a 2-inch layer of the same size stone, and on this second layer of stone, before it is rolled, spread an inch of Kentucky rock asphalt. After again thoroughly rolling the pavement is ready for traffic.

This system of road construction is simpler and requires less labor than the old macadam road, saving the handling of several grades of stone and one or two rollings. After it is turned open to traffic it beats down much harder and quicker than the others, and is never dusty, muddy nor slippery.

The reason that it is never dusty is that Kentucky rock asphalt, being of an oily nature, does not form dust. Should dirt be carried on the roadway from an adjoining unpaved road, it can be washed or swept off with as little damage to the roadbed as to a regular asphalt or brick pavement. The oily nature of the asphalt causes it to pack hard around the crushed stone, making it impossible for water to be absorbed. For the same reason, no matter how steep the grade may be, it will not wash.

It is claimed that the Wadsworth macadam roadway will outwear a limestone macadam or sheet asphalt pavement, because the wear does not come on the asphalt but on the stone. The asphalt simply works down into the crushed rock formation, packing the stone together and making a stone pavement—the most durable pavement known.

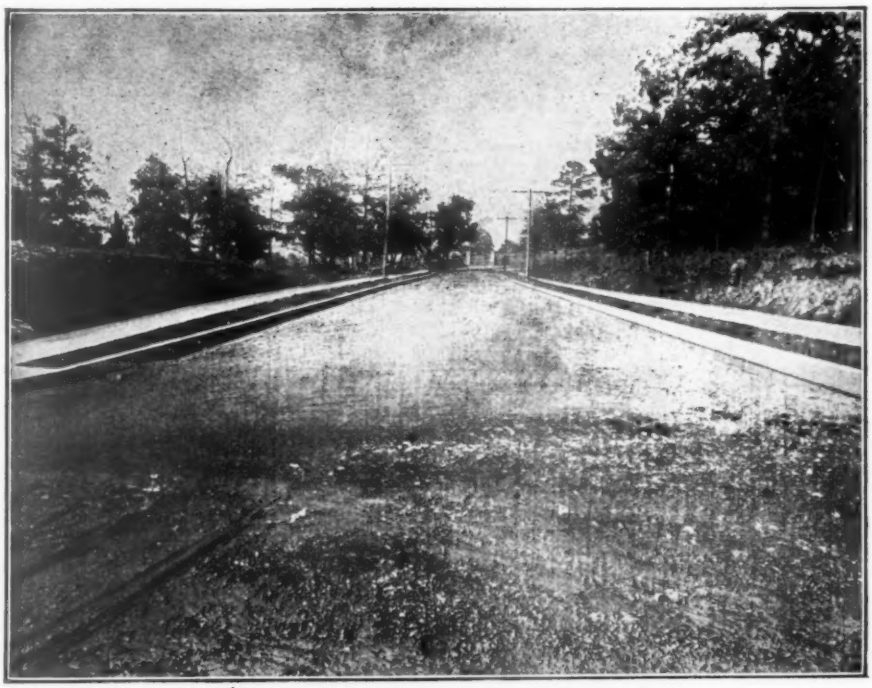
The following letter from Mr. John Oman shows that Kentucky rock asphalt was used ten or twelve years ago in Nashville:

About ten or twelve years ago there was a sample carload of Kentucky asphalt sent to Nashville and put down at the intersection of High street, now Sixth avenue, and Union street. The surplus of raw asphalt left after putting down the sample, was taken to a street near Ransom's lumber yard and put down on the ordinary macadamized surface without being heated or prepared in any way. Some years after this, Mr. M. Nester, then one of the members of the board of public works, called my attention to this asphalt. The rest of the street had worn down, showing the asphalt above the surface. Mr. Nester was very anxious at that time for the city of Nashville to try what he called raw asphalt, but for some reason his idea was never carried out, although the sample stood the test of very heavy hauling on it for a number of years, far better than the heated or prepared asphalt.

The Wadsworth Company says that the man who really introduced Kentucky rock asphalt for macadamized road purposes was Mr. James A. Omberg, Jr., city engineer, Memphis, Tenn. He made his experiment by dumping a small quantity

in a worn-out piece of brick pavement. In a week's time he found the regular traffic over this spot had packed the asphalt down until it had every appearance of a regular sheet asphalt repair job. He was so pleased with his experiment that he immediately built two blocks on one side of Forest Park. This roadway was built on the macadam plan. It has now been in use a year and is so satisfactory that seven more blocks have just been laid.

Last April Messrs. Dunn and Lallande Bros., Birmingham, Ala., laid a sample block on Hall avenue, leading to the Country Club. The accompanying photo-



WADSWORTH ASPHALT MACADAM ON HALL AVENUE, BIRMINGHAM, ALABAMA.

graph, showing a chert road in the foreground and the Wadsworth macadam beyond. Practical road men call it the best piece of macadam roadway they ever saw.

Bowling Green, Ky., is the latest town to try the Wadsworth macadam. The following editorial from the Times-Journal of that city shows how this system of road building is being received:

The asphalt has been put down on a section of the public square and is already being beat down by the travel over it. The experiment gives every promise of proving entirely successful, and if it does, in a few years all Bowling Green's principal streets will have asphalt surface. The streets will then be less noisy, more durable, not subject to wash by heavy rains and considerably less expensive than the streets as they are built at present.

The initial cost of the Wadsworth macadam is 15 to 25 cents per square yard higher than ordinary macadam, but is soon recovered in the extra cost of maintenance. No matter how level the roadway may be, or how well a macadam pavement may be constructed, it will wash, requiring constant repairing at considerable cost per year.

The Wadsworth macadam will wear out and need repairs the same as an asphalt pavement, but is much easier repaired. All that is necessary is to place some broken stone in the low spot and spread a coating of asphalt over it,—a steam roller will help, but the regular traffic will give the packing necessary.

The comfort of traveling over a roadway as dry and free from dust as the best asphalt pavement, yet lacking that noisy clatter, is to be considered. True, no roadway could be better than the old macadam when it is in prime condition, but it soon loses its perfection. The public is clamoring for better roads. Paving is too expensive for the country districts, macadam and gravel roadways are not satisfactory.

The principal advantage of using Kentucky rock asphalt for macadamized roads is that it posseses qualities of a regular asphalt pavement, at half the expense. The Wadsworth Company is offering sample cars at a 25 per cent. discount. Municipalities interested in bettering their highways should write to them for full particulars. Their address is 405 Bessemer Building, Pittsburg, Pa.

Sewers of Reinforced Concrete Pipe.

It has long been the study of able and eminent municipal engineers to so construct the sewers in their various municipalities, so as to make them absolutely sanitary. Engineers of late years have specified both the interior and exterior of sewers be lined by a thick coating of Portland cement and sand. Usually this is made in proportion of four parts of coarse sand to one of cement. The purpose of this article is to bring to the notice of engineers and parties directly interested in planning new sewerage systems or replacing old to an invention of much value in the buildings of sanitary and storm water sewers.

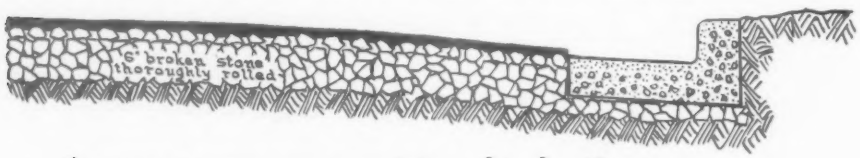
The Jackson Cement Sewer Pipe Company, of Jackson, Mich., are the patentees and owners of molds and machinery for manufacturing reinforced concrete pipe for laying sanitary sewers complete in every respect. Their pipe should require no repairs, for the longer concrete is in the ground the harder it becomes.

Some photographs of a sewer now being constructed of this pipe in their home city have been taken and are reproduced.

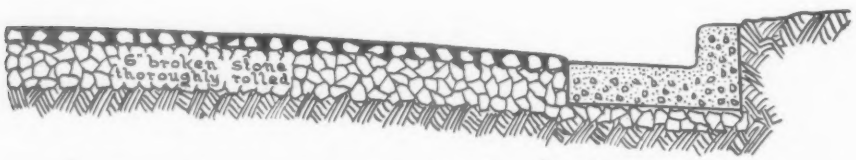
The first cut shows the building of a 5-foot reinforced concrete sewer, and the lowering of a 5-foot pipe into the ditch. This pipe can be made in any size, from 15 inches to 10 feet in diameter.

The particular feature that appeals to every engineer and experienced sewer builder is the manner in which the joints are coupled together by an iron band running around each joint of pipe and through the loops of the iron bars which are embedded in the cement and run through the pipe. When this coupling is made the joints are cemented and thus is formed one continuous piece of pipe. The cement adhering to the iron bands makes the joint as strong as any part of the pipe. With the work well done seepage is done away with. In a sewer constructed of this pipe nothing should get into it or out of it except at the inlets or the outlet.

The second cut shows the reinforced concrete sewer pipe, made along the line of sewer construction. This is a great advantage, as it saves the large expense of freight and gives all the work to home labor, which appeals to every city.



Section showing roadway before final rolling

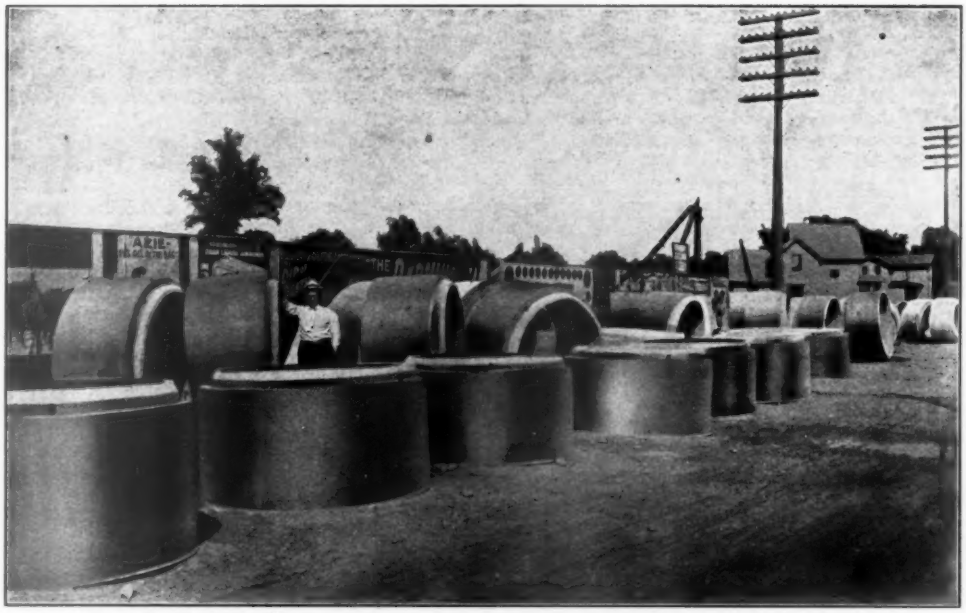


Section showing roadway after final rolling

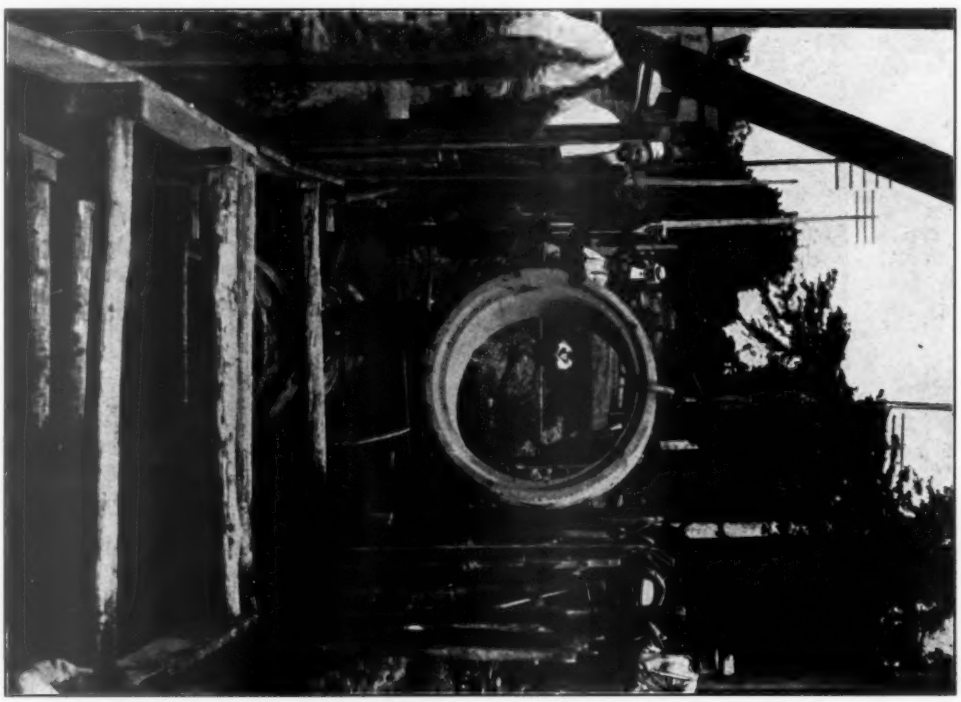
WADSWORTH ASPHALT MACADAM.

The third cut shows a section of reinforced concrete sewer pipe, 3 feet in diameter, ninety days old, carrying a weight of 20,000 pounds. This shows the srrength of the pipe and removes all doubt in this respect regarding the practicability of adopting reinforced concrete sewer pipe in the construction of sewers.

Other points of advantage in reinforced concrete sewer pipe are that they can be constructed as cheaply as with any other material; they harden and strengthen with age; they require no repairs; they are both frost and root proof and are adapted to any climate. They are a municipal economy and are fast gaining the favor of engineers. Not only are the pipe in great demand for sewers, but electric and steam railways are adopting them for



REINFORCED CONCRETE SEWER PIPE.
Made on the line of the sewer.



MONKEY RUN SEWER, JACKSON, MICHIGAN.
Reinforced concrete, five feet diameter.

use in culverts and waterways under their tracks, as they deem them stronger and more durable than iron pipe.

City engineers who have sewer construction in contemplation should investigate reinforced concrete sewer pipe before final decision on materials is made.

The Functions of a Garbage Crematory.

Household garbage is brought to a crematory saturated with water, and in this condition dumped into the crematory furnace. It can not be burned until a large proportion of the water contained in it has been evaporated, not altogether because it is wet, but because it packs, so that air can not be forced through it as through a bed of coals. Therefore the first function of a garbage crematory is to dry the garbage. The evaporation of this water from the garbage is precisely analogous to the evaporation of water in a steam boiler except that in the crematory the evaporation takes place at atmospheric pressure.

But if we merely evaporate the water in this manner we also produce very offensive odors from the distilling garbage. To destroy these it is necessary to raise the temperature of all the gases of evaporation and combustion, after they have left the garbage, to the temperature at which they ignite with air, practically not less than 700 C (1200 F) and to thoroughly mix them with a sufficient quantity of air at that temperature.

TEST OF REINFORCED CONCRETE SEWER PIPE.
A three-foot section carrying 20,000 pounds.

Thus it is evident that sufficient heat must be supplied direct upon the garbage to evaporate the water absorbed in it, somewhat above 100 C and then enough heat applied to these gases to raise them to 700 C. The evaporation requires about the same amount of fuel as to evaporate the same weight of water in a steam boiler; the subsequent superheating of the steam produced in the crematories requires about 45 to 50 per cent. as much.

additional fuel, if the process is economically conducted.

But when the garbage becomes dry enough to burn, if furnished sufficient air the problem is no longer one of evaporation but one of stoking and of getting the air to the garbage so as to cause perfect and rapid burning. In this part of the process the garbage is itself fuel, and its heat may be used to dry other garbage or to cremate odors.

Obviously a hearth or grate adapted for the first process is not equally adapted for the second and to secure the best results the garbage should be stoked to a burning grate arriving there in a loose condition, where it may be easily burned, producing, if dry, about the same amount of heat as an equal weight of dry wood or half its weight of good coal.

As all of the gases that leave the crematory must be brought to a temperature of 700 C or more in order to be odorless when discharged, it is quite evident that a large amount of heat can be regained by using a steam boiler in the passage between the crematory and the chimney. The weight in pounds of steam that could be generated is equal to that which the dried garbage alone could generate, plus that which the other fuel could generate, less about one and one-half times that required to evaporate in a boiler a weight of water equal to that originally in the garbage. Where kitchen garbage only is burned this available heat would never exceed the amount that could be raised by the auxiliary fuel alone, and seldom if ever reach that amount. Therefore steam boilers are not advisable in connection with the flues of small garbage crematories. But where there is mixed with garbage a sufficiently large amount of other refuse of a combustible nature and where the plant is large the question of steam raising should be considered if steam is desired for other purposes. Use of the furnace gases after complete burning for steam raising does not involve any changes in the construction of a crematory itself. It is merely a utilization of heat otherwise necessarily wasted. But the temperature of these gases varies from a minimum of 700 C at the commencement of burning to a maximum of 2500 C when all the water has been evaporated, which is a wider range than is ever to be provided for in steam boilers under ordinary conditions, and requires special consideration in selecting the size and type of the boiler to be used.

The Sanitary Engineering Company, 237 Broadway, New York, advise regarding the installation of crematories and the utilization of heat in waste gases where possible with economy.

Castings for Municipal Use.

The Canton Foundry and Machine Co., Canton, Ohio, make a line of castings for municipal purposes, which are well designed and constructed and should give good service. They include rings with locking covers for sewer and conduit manholes, with lugs for holding dirt pan, lamp hole covers, the diamond street plate of all sizes and angles, gutter boxes and extension gutter boxes of any cross section and 4 to 7 feet long, with flanges for laying longer gutters and covers of any desired length or width for use at street crossings, catch basin covers with grated inlets for storm water, waterworks manhole covers, etc. They supply a demand, which has appeared several times in the Question Department of this magazine, for an adjustable valve box, their box having a bell from 7 to 10 inches in diameter which extends the box to any desired length.

The company also supply doors and frames for furnaces, ash pits, ovens, etc., gratings, sewer connections and boots for storm water pipes from houses and yards, stable gutters, door and stair plates, posts, weights, coal hole covers, etc. Ask them for catalogues.

Sewer Pipe Machinery.

An excellent line of machinery for making sewer pipe and tile is put on the market by The Turner, Vaughn and Taylor Company, of Cuyahoga Falls, Ohio.

The steam presses for forming the pipe have some most convenient features about their arrangement. All the levers for operating the various parts of the machine are within the radius of the reach of the press-man. One controls the steam piston valve, one the steam dummy or lever-man, one the brake-lever controlling the lowering of the balanced disc rod and former and the hand-wheel and drum for raising them. The filler and storage box is also controlled by the operator in charging the press. The company brought out the first presses in 1869 and has kept abreast of improvements in design and economy of operation ever since.

Pipes of any sizes, from 2 to 42 inches diameter, can be made on the seven sizes of presses, using the proper dies.

The company furnishes dies for all sizes and designs of standard and double strength socket pipe and round tile, as well as for sewer inverts, brick, chimney pipe, round, square and oblong flue linings, etc.

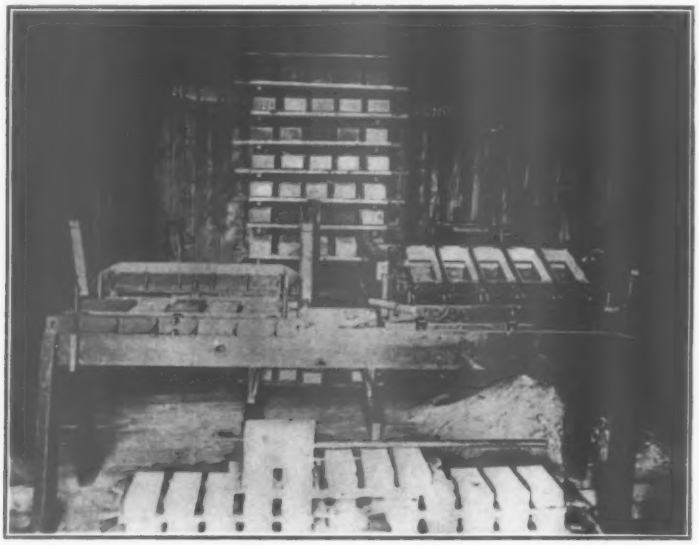
The combination mill for preparing clay for the press has been a feature of the company's business for many years and

it has been improved from time to time to meet changing requirements. It includes the reciprocating wheels of the chaser mill and the revolving bed of the wet pan and thus increases output, with consequent decrease in expense.

The company also furnishes dry and wet pans. Write to them for detailed information.

A New Cement Brick Machine.

The Big Four Machinery and Concrete Works, Winamac, Ind., has now on the market a machine for making brick of cement and sand which has a capacity of 5,000 bricks a day. The accompanying photograph shows the machine and some of its products. It is in reality two machines or sets of molds, each making five bricks at a time, set on the same stand and the operator uses them alternately, thus saving time of himself and of his helpers by keeping all busy all the time.



CEMENT BRICK MACHINE.
Big Four Machinery and Concrete Works.

One of the machines is operated as follows: A pallet, which may be of either wood or iron, is put in the bottom of the machine. This pallet has five sections for the five bricks. The set of five mold boxes is then put in place. The sides and ends of these boxes are moved toward and from each other by turning the handles by which the set is lifted. When in place and closed the sides of the molds are locked by turning up the front of the machine, which is a narrow plate with projections which wedge between the sides of the molds and hold them tightly in place. This front brace is fastened by dropping arms at the ends into notches. The hopper box, hung on hinges at the back, has been out of the way of these operations and is now turned down into place. It locks the rear ends of the sides of the molds. The hopper is slid forward in the hopper box, and the machine is ready to fill. The mixture of sand and cement, "dry process," is filled in and tamped. The hopper is slid back carefully and adjustable scrapers on it smooth off the top surfaces of the bricks and push the excess of material back into the hopper box.

To open the machine the hopper box is then turned back on its hinges and the front of the machine is turned down. Then the handles on the set of molds are turned, moving the mold sides and ends apart and the set of molds is lifted out, being guided so as not to touch the bricks by four pins at the corners. The pallet carrying the five bricks is lifted out and carried away to store. Meantime a pallet has been placed in the adjoining machine, so that when the set of molds is lifted out of one machine it is put in place on the other and the operator proceeds with the two alternately.

One man in front of the machine operates the molds and tamps the bricks, alternately in the two machines. A boy puts in the pallets and shovels in the materials. Another boy takes out the filled pallets and carries them away.

Bricks of any desired face may be made by changing the sides of the individual molds.

The double machine occupies a floor space about 6 by 2 feet.

The company prefers to equip plants of 20,000 daily capacity and will quote prices on equipments on application.

Hose Reel and Fire Department Apparatus.

We have received from the Wirt & Knox Mfg. Co., of Philadelphia, a copy of their handsome new catalogue "B," just out of press. This is a most attractive presentation of the line of goods manufactured by this well-known house, and comprises their line of factory, mill, village and fire department hose carts, as well as their hump and angle iron swinging hose racks, wall reels, etc., etc.

In this catalogue the company illustrates and describes several new styles of hose carts, as, for instance, Figs. 600, 700 and 800, forged frame carts, which they are introducing in response to a demand for a line of carts of this form of construction. All these styles are made in several sizes, of varying capacities. They illustrate also a new size of their well-known style "M" village hose cart, of a larger size and capacity; also a new fire department jumper, Fig. 900, which they list in three sizes. This is in addition to their style "K" carts, heretofore illustrated, though of similar design, construction and equipment. The former styles of wood-wheel carts are continued, and the company desire to call special attention to the design, construction, finish and equipment of these carts, which they claim are in every respect in the lead.

They especially commend their line to the notice of village fire departments, to whom special attractions are offered. They will be pleased to forward copy of catalogue to any one interested and who will write them for it. Address Wirt & Knox Mfg. Co., 18 N. 4th St., Philadelphia, Pa.

Klein's Granitoid Walks.

J. J. Klein, builder, Iola, Kans., is the trademark appearing on the work done by this veteran contractor and he has issued a booklet, showing that it is "a sign of perfection" and that his walks are a standard. Mr. Klein learned his trade in St. Louis with the inventor of the granitoid walk and has built many miles of walk, curb and gutter, driveways and crossings in many cities and towns in Missouri, Kansas and Texas, and in New Orleans and Memphis. He opened this year an office in Dallas, Texas, under the name of Klein Bros., and municipalities and others having this class of work in prospect will do well to ask Mr. Klein for prices at either his Iola, Kans., or Dallas, Texas, office.

Concrete Blocks vs. Mortar Blocks.

Mr. Noyes F. Palmer, Brooklyn, N. Y., sends the following information regarding tests of concrete and mortar blocks made by him and tested by the ordnance department, United States of America, on the U. S. testing machine with capacity of 800,000 pounds, at Watertown Arsenal, Mass., July 7, 1905. The test is No. 13,250, and is by compression:

One mortar block and one concrete block received for testing; each was cut into halves to permit of testing. Compressed surfaces faced with plaster of Paris.

Description	Sectional Area Sq. inch.	First Crack Pounds	Ultimate strength	
			Total Pounds	Per sq. in. Pounds
Mortar, 1st half	154.90	399,800	399,800	2,580
Mortar, 2d half	157.23	339,100	339,100	2,160
Concrete, 1st hf.	159.38	442,000	491,000	3,080
Concrete, 2d hf.	158.30	471,000	482,000	3,040

In July Mr. Palmer sent these as whole blocks, and it was necessary to cut them into half blocks to permit of a complete test, as the ultimate strength of the whole blocks was greater than the capacity of the machine. The sums of the mortar half blocks and of the concrete half blocks show that the entire mortar block would have sustained at least 738,900 pounds and the concrete block, as a whole, at least 973,000. These whole blocks, as a unit in a wall, would have sustained proportionately more than as half units, because of the center cross bond.

The mortar blocks referred to were at least one-third hollow, and were nine months old at time of test; and were hand tamped in his adjustable machine. The mix consisted of one part Portland cement, and four parts ordinary bank sand. They were made in the usual manner without any special care for a test.

The concrete blocks refeerred to were at least one year old, and one third hollow and were hand tamped in his adjustable machine. The mix consisted of one part Portland cement, three parts bank sand and five parts broken stone, egg size with all screenings included.

Mr. Noyes F. Palmer also calls atten-

tion to the necessity of solid bottom and sides to molds if perfect form of block and thorough consolidation of material are to be obtained. Besides the difference in strength between concrete and mortar blocks of standard proportions of materials, he also calls attention to the certainty of great reduction in strength of mortar blocks made in proportion of 1 part to say 8 of sand.

Street Cleaning Machinery.

Mr. J. H. Strain, who was formerly with W. C. Oastler and with the American Road Roller Company during its existence, has now established himself in business at 254 East Twenty-first street, Brooklyn, N. Y. He builds a street sweeping machine, which he styles the "A. B. C." or "American Barnard Castle," of a type which has long been in use in many cities in this country and elsewhere. He supplies and refills the brooms for sweepers and also supplies pavement scrapers, push brooms and other street sweeping and cleaning machinery. The pavement scraper is said to remove the lightest accumulations of mud from macadam streets without injury to them, depositing the mud in a line as does a street sweeper.

Mr. Strain also deals in the scarifier for picking up old macadam roads ready for new material and rolling, and is building steam road rollers, his small steam roller being now ready for inspection.

The hardware trade is also supplied with brooms and brushes for all uses, outdoor furniture, stable fixtures, builders' iron work, etc. Send to him for a catalogue.

The Ideal Concrete Block Machine.

The Ideal Concrete Machinery Co. of South Bend, Ind., are publishing a monthly sheet showing points to which they are shipping their Ideal block machines. These lists are headed by the words, "Straws which show the way the wind blows." We are in receipt of their June list, which is given below. We find in this list that a machine was shipped to the Philippine Islands, proof that even such distant points are becoming interested in concrete block construction.

Jerseyville, Ill. (4); Greenville, Ohio; Troy, Ohio; Hope, Ark.; Alton, Kans.; Latonia, Ky. (2); Ridgefield Park, N. J.; Muskogee, Ind. Ter. (3); Minneapolis, Minn.; Irving Park, Ill. (2); Springfield, Ill.; Florin, Pa.; Burlington, Ia.; Armour, S. D.; Tyndall, S. D.; Cairo, Ill.; Kensington, Kans.; Chenoa, Ill.; Ligonier, Ind.; Decatur, Ind.; Owosso, Mich.; Bowling Green, Ohio; Lagrange, Ill.; McLean, Ill.; Bradford, Ohio; Atlanta, Ohio; South Omaha, Neb.; New Brighton, Pa.; Meade, Kans. (2); Freeport, L. I., N. Y.; Mishawaka, Ind.; Covington, Okla.; Dayton, Ohio; Chattanooga, Tenn. (3); Kokomo, Ind.; Springfield, Mo.; Zamboanga, Island of Mindanao, P. I.

Architectural Ornamentation in Artificial Stone.

The Detroit Architectural Stone Dressing Co., Eighteenth and Magnolia streets, Detroit, Mich., has recently furnished the trimmings for a new brick building which increased the interest of the building trade in concrete construction on account of their excellent form and finish. The building has the artificial stone moldings from water table to gable and the supervising architect considered it a well put up job. This company supplies in artificial stone, balusters, rails, posts, quoins, caps, porches of stock designs or with details as ordered, cornices, arch stones, steps, plain and molded, etc., and will give full information to those who are interested.

A Sanitary Garbage Incinerator.

On August 8 a test was made of the new garbage incinerator, constructed for the city of Muncie, Ind., by the Decarie Manufacturing Company, of Minneapolis, Minn.

This type of furnace is comparatively new, that at Minneapolis, the first constructed, having been in operation less than five years. The accompanying photograph shows the exterior of this building. That at Muncie is somewhat smaller in size. The company has already constructed furnaces in Brooklyn, N. Y., in several Pennsylvania cities, in Tampa, Fla., Atlanta, Ga., Seattle, Wash., and elsewhere and recently took a contract for a furnace at Los Angeles, Cal.

The writer had an opportunity to observe the test of the Muncie furnace of the results of which a few statements are appended from the report of Mr. H. G. Bayles, of New York. The furnace is described as follows:

The building is principally of wood, built in the heavy mill style of construction. A long runway, with a grade of 1 1-2 inches to the foot, leads from the road to the upper floor, where the carts are dumped into the furnace. The floor over the furnace is built of steel I beams with brick arches between, and the whole covered with 2 1-2 inches of neat cement. Four cast iron columns, not connected with the furnace, support this construction, supplementing the 10x12 inch floor girders that rest on the wooden pillars.

The furnace itself is entirely of steel and wrought iron. Its inside dimensions are 10 ft. wide, 9 ft. long and 10 ft.

high. The top or crown is formed by a steam and water space 18 inches high, made of heavy steel plate, stay-bolted at frequent intervals to enable it to support the steam pressure. The upper grate is formed of 1 1-2 inch extra heavy wrought iron pipes. These extend from the two headers that run along the lower part of each side of the furnace, pass each other like interlocked fingers about a foot below the crown, and enter the top steam and water space. The downward circulation of water is provided for by four vertical 6 inch wrought iron pipes, one at each corner of the furnace, extending to the floor. These connect the corners of the crown with the ends of the headers, which are carried outside the furnace wall, and also serve to keep the weight of the crown from the side walls.

Three different classes of waste matter are provided for by five chutes, all opening from the upper or dumping floor. Two of these are for moderately dry kitchen garbage, manure, etc., and deliver the material straight to the upper grate, where it is dried and partly burned, and from which it falls to the lower grate to complete its combustion. Two hoppers, one each side of the furnace, are built externally, and provided with cast iron sliding doors. These hoppers are for very wet material, such as very wet kitchen garbage, swill, night soil, etc. The doors hold back the material while its excess of moisture is drained through a pipe into the evaporating pan. When the doors are lifted, gravity delivers the refuse to the upper grate. Small doors are provided in which to insert pokers in case the refuse blocks. These side hoppers were not used during the test run. The fifth chute is for dry combustible refuse, such as paper, wood, boxes, barrels, straw, etc., and delivers the refuse directly to the lower grate at the front end of the furnace.

DECARIE GARBAGE CREMATORY AT MINNEAPOLIS, MINN.

The gases of combustion rise from the lower grate through the upper grate, drying any wet material held there, and then out of the furnace proper. They enter first a combustion chamber filled with

brick checker work, then pass through two horizontal brick-lined flues about eight feet long and ten feet above the floor. From this height they are deflected downward to nearly the floor level, where they strike the water chamber, placed there to catch and hold any solid particles that may have been carried out of the furnace. The gases then pass between upper and lower fume consuming grates. Then they pass over a baffle wall, under another, getting a downward velocity a second time and striking a second water chamber. They then enter the stack, which is 4 ft. inside diameter and 127 ft. high and brick lined to a height of about 25 ft. At no time during the test run was the smoke issuing from the stack anything but white and odorless. The test run was for 24 hours.

The laborers employed in stoking the furnace were two men in the day and two men in the night, acting under the direction of Mr. F. L. Decarie and his son. These men were paid $1.50 apiece. Two boys to stoke on the upper floor cost $4. Three men were employed for two hours in cleaning out the ash and evaporating pan, at a cost of 90 cents. No coal was used in the furnace. The only wood fuel 92 E. High St., desires to purchase maused in the furnace was what came with the collection of combustible refuse. This source of supply for boxes and barrels would probably be much less reliable in winter or in time of a fuel famine. There was about half a cord of this wood. The same quantity of 4-foot oak cord wood, if it was necessary to buy it, would cost about $2. Eight hundred pounds of coal were used in the fume cremator and 30 gallons of oil in the furnace. The total cost for labor and fuel was:

Labor	$10.90
Wood	2.00
Oil	1.05
Coal	1.00
Total	$14.95

The total kitchen garbage put into the furnace was 29 1-2 tons. This includes the dead animals. The night soil was a little over 4 tons, and the combustible refuse, 10 tons. The furnace received in all, therefore, 43 1-2 tons, during the 24 hours.

At 9:30 a. m. of the 9th inst., 24 hours after the light was applied to the furnace, I made careful inspection of the entire plant, including the platform on which 29 tons of kitchen garbage had been stored; the upper floor, on which there had been 12 1-2 tons of combustible refuse, and the interior of the furnace itself.

The platform was completely cleaned. The upper floor still held 2 1-2 tons of combustible refuse. In the furnace were 1 1-2 tons of partly burned kitchen garbage and not more than 3-4 of a ton of combustible refuse that was not in a state of bright incandescence or already reduced to ash.

Deducting the amount of unburned material in the furnace at the end of the test run, 2 1-4 tons, the amount of waste material completely burned in the time specified by the contract was 41 1-4 tons.

No stoking was done after the 24 hours, and the material left in the furnace burned itself out completely in a short time. The cost of labor and fuel per ton of refuse consumed was 36 1-4 cents, or over 25 per cent. below the contract price.

The Decarie furnace meets the objections to some other furnaces as regards cost of fuel and repairs most satisfactorily. It is not a brick arch furnace, but is of steel, water-jacketed, and with water grate bars forming its upper grates. The manner in which the material in the upper grates is exposed to the full drying action of the fire on the grate bars below, utilizes the largest amount of the heat possible in drying the wet garbage, and therefore the extremely high temperatures of the successful English furnaces are not required. The absence of brick arches and the thorough provision for the expansion and contraction without straining the furnace, reduce the bills for repairs to a minimum. The oldest Decarie furnace has been in operation scarcely five years in Minneapolis, and the bills for repairs on this furnace have been less than $20 during that time. The coal used is restricted to that for the small furnace for burning the gases from the large furnace, which amounted to 800 pounds for the 41 1-4 tons burned during the test, and may be still further reduced by using dried refuse and garbage in that furnace.

Points Worth Considering.

The Superior artificial stone machine makes the stone with the face down, or in the bottom of the flask, which permits the use of fine rich material for the face and a much coarser, cheaper material for the main body of the stone.

By tamping directly upon the face, a uniform and superior face is made.

The stone made with the Superior machine is an exact imitation of fine cut Bedford or other natural stone, at a moderate cost of production.

The blocks have large oblong holes through them for ventilation and to make a dry wall.

The Superior machine makes a stone that is absolutely true and mechanically perfect. The blocks are laid in the wall with close joints, and the mortar or cement is placed in the mortar joint provided through the sides and ends of same. No wedging up of blocks is needed and no pointing up is required. They do not require a skilled mason to lay them.

They are discharged from the machine with their face up, on inexpensive wooden boards, on which they are taken to the curing shed. This saves a large outlay of money for expensive iron pallets, as it requires five or six hundred of these pallets to properly operate a machine. By curing the blocks with the face up, the water, necessary for curing them, can be poured directly on the face, thus evenly distributing the water and preventing streaks in the face of the blocks.

These items are worthy of careful consideration when making comparisons of machines.

The Superior machine is made by the T. O. Eichelberger Company, Dayton, O., and is covered by U. S. patent No. 791,088, issued May 30, 1905.

The Great New Industry.

The Miracle Pressed Stone Company, of Minneapolis, Minn., issues a handsomely illustrated catalogue with the above title. It shows the full operation of making a Miracle block in all its stages, views of block plants and of air space block molds and machines, sewer pipe molds, sidewalk tile machines, fence post molds, and concrete brick machines, and sells cars for handling blocks, concrete mixers, tampers, block lifters, joist hangers, sidewalk and other cement tools, and all machinery and supplies for cement users. These are all fully described and illustrated in the catalogue, which will be sent on application.

MIRACLE COMPANY'S CONCRETE BLOCK EXHIBIT AT PORTLAND FAIR.

houses, churches, flats, armory and opera house, etc., built with the blocks. The accompanying photograph shows the office of the company at the Portland Fair, and gives a good idea of the standard and the ornamental work which is possible on the machine.

Lists are given of the parts for the various outfits furnished by the company for standard blocks, for bay window or octagon work, for porch columns, piers and chimney blocks of various sizes, for window sills and caps, for veneers, wreath belt course, broken ashlar, egg and dart cornice, half height blocks, etc., making, altogether, an outfit which should meet all demands from the architects.

Many of our readers will be interested in the plans for dwellings and offices which are shown in the catalogue.

The company also makes several single

Effect of Shape of Mold on Concrete Blocks.

Mr. H. S. Palmer continues his discussion relating to the shape of molds best adapted to produce good work and the best stone, as follows:

Rigidity of the mold within reasonable limits has much to do with the density of tamped stone. No good stone can be made in a "box nailed together and tamped full," as suggested in the article written by Paul Wilkes. As he correctly says, such stuff does not deserve the name of stone. Many are the dollars which have been lost by trying to save 5 cents in buying the lumber for the molds. In the course of time it was learned that the proper strength of molds depends upon the size and shape of stone desired. To illustrate we will take a door sill 5 feet long, 12 inches high and 6 inches thick. This should not be tamped flat-wise, but on its edge with the thin part down, if the sill is sloping. Now if the sides were only 2 inches thick, they could not support the tamping which would be necessary to make good work and waterproof stone. They would bulge out, producing imperfect stone in shape and density. To cover this defect in the mold some means must be employed

such as thicker lumber, longitudinal webs, iron bolts passing through the sides or clamps to hold the sides together, in which ways sufficient strength could be given to the mold to hold it firm as to the sides. But now comes the bottom. In most cases the sides were simply set loosely upon a common board, usually 2 inches thick, with cleats nailed across, to keep the same from warping. This device was considered an ideal mold and thousands of dollars' worth of stone has been made in this way, as well as thousands of stone that were not worth a dollar, because of the lack of precaution in making the mold rigid enough. Resting the mold upon a loose bottom of boards is not the right way to get the best results. There is not the proper resistance to retain the effect of the rammers. From the above method, which is too commonly practiced at the present time, grew the better one of using iron of sufficient weight to give stability and rigidity combined with correct mechanical construction. Some stonemakers did fasten their mold to the bottom with hinges, but this only partially overcame the difficulty.

The proper method of procedure is as follows: Have your mold of sufficient weight relative to the size and weight of the stone you wish to make, then have all parts rigidly secured together in such manner that no spring or yielding of any sort can take place. When your mixture is in the best stage to tamp, shovel the same into the mold and pound it down hard with rammers of the proper weight, and of the right size compared with the area of the surface to be tamped; the desideratum being to prevent the material from breaking up around the tamper, which it will not do if the space is not too wide between the tamper and side of the mold. If everything is right the stone "paste" is driven "home." It is held there so firmly that repeated blows have no effect, except to compact it still more and when the cores are withdrawn and the sides loosened it will remain in its firm and compact condition until the cement hardens the mass into a "stone" instead of a concrete "lump."

We have now found that good stone can be made, possessing all requirements as to strength, density, color, cheapness and lasting qualities, and we have now to consider how best to adapt it to building construction. It is admitted that the hollow stone is preferable to solid on account of its cheapness and sanitary qualities, besides many others, but to adapt it to general use there are many things which must be carefully studied as a basis for proper methods. The following are a few of the problems to be attacked:

Adaptability for use in plain work; best methods for producing ornamentation; proportion of cavities for different work; conditions governing the height and length of blocks; proportions of cemetn and aggregate; size of hollow blocks for general use; dividing hollow blocks under units of measurements; advisability of using return corner blocks; methods of holding frames in the wall; securing and seating joists and timbers; best method of raising chimneys with the walls; construction of sills and lintels; plastering directly to the walls; coloring of artificial stone; waterproofing and damp-proof stone; curing and caring for the newly made blocks; efflorescence and its prevention; expansion and contraction of hollow walls causing cracks; foundations and excavations; desirability of standard sizes of hollow blocks; comparisons as to cost with other materials; wet and dry process of manufacture; facing artificial hollow block with richer mixture; concrete in the form of hollow blocks as a fireproof material; hollow block architecture.

It would seem the part of wisdom for those who wish to engage in the business to spend some time in learning the fundamental principles of hollow block construction.

A Traveling Garbage Crematory.

Col. Isaac D. Smead, of Cincinnati, Ohio, is at work upon a traveling crematory for garbage and refuse, which is nearly ready for use. He proposes to haul it through the alleys or streets and dump the garbage and refuse from the receptacles in which it is placed by the householder into it and burn them on the spot without nuisance, believing that he can do this with less expense than the present methods require. If his experiment is successful he will solve a most perplexing problem. Colonel Smead will doubtless give further information if he is addressed at 141 E. Fourth St., Cincinnati, Ohio.

Bitulithic in Portland, Ore.

A contract for 27,446 square yards of bitulithic pavement has just been awarded by the City Council of Portland, Ore., to the Warren Construction Company. The first bitulithic pavement was laid in Portland in 1903. It has fully met all the claims of its inventors, and has been so generally satisfactory that last year contracts were made for 62,884 square yards and this year for 41,711 square yards, the contract just awarded being for 14,425 square yards in Second street and for 13,021 square yards in Couch street.

Data on Power Transmission.

The Dodge Manufacturing Company, Mishawaka, Ind., have just issued their 1905 C-7 catalogue—6x9, standard size. This book, containing 416 pages, has been built for the express purpose of furnishing all those interested in power transmission equipment with the most up-to-date and dependable data that can be compiled, making it a veritable text-book on this subject.

A most commendable feature is the coding of the entire book in alphabetical order. Certain combinations have been effected requiring but one code word to designate certain information that in tables and price lists, as ordinarily coded, takes from eight to ten words.

The American system of rope transmission has been entered into and exploited very thoroughly.

This standard edition is bound in library style, with rigid backs, and is intended for desk purposes only. To meet the demand for a 4x6 pocket edition a complete reduction will be made, which will be known as C-7 Junior, and will be ready for distribution about September 15.

Trade Publications.

Anderson & Sons Co., 21 St. Aubin avenue, Detroit, Mich., issue a booklet containing specifications for artificial stone sidewalks, each step of the process being illustrated, with the tools required for it and the methods of applying and using the tools, from the shovels for handling gravel to the stamps for lettering walks and the lanterns and guard rods for protecting the finished walk until it has set.

The P. B. Miles Manufacturing Co., of Jackson, Mich., issues a handsomely illustrated catalogue which will meet the expressed desire of several correspondents for views of buildings of concrete blocks, as it has photographs of three stores, four dwellings, several views of a church and a small office building, as well as pictures of their machine on which the blocks for the buildings were made, and many letters from those who have used them.

The Steel Highway Track Construction Co., Drexel Building, Philadelphia, Pa., sends two photographs of the old Butler plank road, near Pittsburg, before and after their steel track roadway was put in, to show the improvement and to announce a new illustrated booklet to be had for the asking.

The International Instrument Co., Cambridge, Mass., sends bulletins 350, 361, 601 and 701, descriptive of the Johnson cement testing machine and apparatus for testing road materials, a rain gauge and centrifuges for bacterial and chemical research laboratories.

The latest number of "The Doings of Expanded Metal," published by the Associated Expanded Metal Companies of New York, is devoted mainly to expanded metal concrete columns, shop and factory construction and resistance of such construction to fire.

The Marquette Cement Manufacturing Co., Marquette Building, Chicago, Ill., issues a circular giving "Instructions for the Manufacture of Concrete Building Blocks."

Krupp patent tube mills, with continuous feed and discharge, for dry grinding all materials, are fully described in a pamphlet issued by Thos. Prosser & Son, 15 Gold street, New York City.

The College of Engineering of the University of Wisconsin issues a bulletin regarding a course in chemical engineering.

Trade Notes.

ASPHALT.

Indianapolis, Ind.—Special.—The National Bitumen Company, of this city, has purchased of the F. D. Cummer & Son Company, of Cleveland, Ohio, a complete semi-portable asphalt paving plant, the same to be erected in Paris, Ky.

Seattle, Wash.—The plant of the Independent Asphalt Co., at 19th St. and Highland Drive, was damaged by fire August 6, entailing a loss of $500.

Milwaukee, Wis.—The Central Bitulithic Paving Co., of Zanesville, Ohio, was incorporated under Wisconsin laws, August 10, according to press reports.

Obispo asphalt has now been in use for over five years in thirty cities, with 250 miles of streets. It is refined by the Globe Asphalt Co., of Pittsburg, Pa.

BRICK.

Milwaukee, Wis.—The Hydraulic Stone & Brick Co. has been incorporated to take over the property at Janesville, in which A. H. Spoor, Walter B. Potter, A. J. Pick and others have been interested for some time.

Jacksonville, Ill.—The Jacksonville Sand, Cement & Brick Co. is being organized here to deal in building material, by Robt. R. Buckthorpe, Wm. H. Cockring and Thos. H. Buchthorpe.

Boise, Idaho—The Boise Building Material Co., Ltd., has been incorporated to engage in the manufacture of sand-lime brick.

Baltimore, Md.—The plant of the Baltimore Vitrified Clay Co., at Westport, near this city, was damaged by fire recently.

Fort Collins, Colo.—The Poudre Valley Pressed Brick Co. has been incorporated to manufacture pressed building brick, vitrified paving brick and drain tile. President, Peter English; vice-president, James B. Arthur; secretary, Frank English; treasurer, F. D. Stover.

CEMENT.

New York City—In sinking a shaft for the Pennsylvania-Long Island tunnel the workmen discovered on Manhattan Island a cement rock mine more than 100 feet below the surface of the street.

Anoka, Minn.—A new cement company has been organized by Olof Moline, Gus Nelson and G. Peterson.

South Pittsburg, Tenn.—Philadelphia capitalists, who some time ago secured options on about 100 acres of mountain land and 500 acres of town lots in what is known as Deptford, to erect a cement plant, are now taking in the property and will erect a cement plant.

Jersey City, N. J.—The Logan Portland Cement Co. has been incorporated by John B. Logan, Louis B. Dailey and Thos. F. Barrett.

Buffalo, N. Y.—The Niagara Cement Co. has been organized with officers as follows: President, Wm. B. Ruggles, of New York city; vice-president and general manager, John P. Seymour, New York city; treasurer, Wm. B. Reading; secretary, C. A. Collins. The mill will be designed and built by the Ruggles-Coles Engineering Co., of New York city.

Easton, Pa.—The property of the National Portland Cement Co., located at

Martin's Creek, near here, was sold by the sheriff July 29, to A. F. Gerstel, for $50,000, subject to a claim of $1,500,000, held by the Northern Trust Co., of Chicago, trustee for the bondholders and others.

Pittsburg, Pa.—The Pittsburg Portland Cement Co. has been incorporated by Alexander F. Johnston, James I. DeLong, and Chas. T. Moore. The company contemplates the development of the most extensive cement plant west of the Lehigh Valley district.

New York City—Special—The Vulcanite Cement Co. advises us that it has closed the contract for supplying "Vulcanite" Portland cement for the new West Point on the Hudson river. Some seven million dollars will be spent by the government in making the academy probably the greatest of its kind in the world. "Vulcanite" cement was selected practically by comparative tests conducted by the army engineers at West Point. The first order amounts to 30,000 barrels, part of which has already been shipped.

CONCRETE BLOCKS.

Perth Amboy, N. J.—The Raritan Cement Stone Mfg. & Contracting Co. has been incorporated to manufacture cement stone and other building materials, by N. C. Neilson, Andrew K. Jensen, Chas. A. Mundy and Louis DuBois Watson.

Milwaukee, Wis.—The Hydraulic Stone & Brick Co. has been incorporated by Andrew J. Pick, A. H. Spoor and Walter R. Potter.

Hoboken, N. J.—The National Concrete Company has been incorporated to manufacture, sell and deal in concrete in all forms, blocks and bricks, etc., by G. Spencer Ridner, Henry B. Marchbank and William W. Vanderbilt. The company's offices are located at 500 Washington St.

Houghton, Mich.—F. M. Cooper and James Pryor, of this city, have organized a company to resume operations in the hollow concrete block plant at Ripley.

Des Moines, Ia.—J. M. Keith made a shipment recently of cement block machinery to Australia.

New concrete and cement block companies have begun the manufacture of concrete building blocks since the issue of the August number of MUNICIPAL ENGINEERING, as follows:

Henning, Minn.—The Minnesota Cement Brick Co.: E. P. Skahen, R. L. Hall and George H. Markham.

Findley, N. D.—A. G. Nelson.

University Place, Neb.—Earl Thompson.

Warroad, Minn.—N. Shears.

Auburn, Ia.—J. H. Jansen.

Humboldt, Neb.—Joe Graves.

Louisville, Ky.—The Eckert Artificial Stone Co.: Wm. Owens, R. Cullen and Frank Eckert.

Woodward, Ia.—McColl Bros.

Anamoosa, N. D.—Frankhouser Bros.

Scotland, S. D.—Moses Hackett.

Grand Forks, N. D.—J. M. Sturtevant.

Mossman, S. D.—Erwin Bros. & Morfard.

Norwood, Minn.—R. C. Baumeister and W. C. Bradley.

Oshkosh, Wis.—Oshkosh Concrete Construction Co.

Wells, Minn.—Adamson & Perkins.

McIntosh, Minn.—Anton Jensen.

Burlington, Ia.—Bernard Bros. & Mercer.

Greenbush, Minn.—Koffstad & Anderson.

Milford, Ia.—Andrew Barnard.

Long Prairie, Minn.—Paul Lawin and Otto Beseman.

Eau Claire, Wis.—The Chappelle Concrete & Tile Co.

Platteville, Wis.—John Roberts and Victor E. Roberts.

Waterloo, Ia.—C. O. Baldwin has applied for a patent on a concrete mixer which differs materially from those now used.

Youngstown, Ohio—Oliver Turner, 431 McKinnie street, is building seven houses of concrete blocks made on a machine of his own invention.

Iola, Kans.—Special.—The Horton Concrete Co. has recently taken contracts for building the Carnegie library here, as well as several churches at points in this vicinity. These buildings will all be built of concrete building blocks and this concern, after investigating thoroughly the matter of concrete building block machines, has recently installed two of the Hayden automatic block machines in their Iola plant with prospect of installing still further machines as their business increases.

Louisville, Ky.—Special.—The firm of M. T. Lewman & Co., who are extensive contractors of public improvements, have recently decided to branch out in the concrete construction branch of building, and have installed one of the latest design of the Hayden automatic block machines at Waynesboro, Tenn., where they have a contract for building a court house. This concern has headquarters at both Louisville and Atlanta, and expect to install numerous other machines in the near future.

Athens, Ohio—Special—The Rardin Concrete Block Co. have recently completed their plant for the manufacture of concrete block, and are now working to their full capacity in order to fill orders which have accumulated. After referring the matter of concrete block for construction work to various architects to whom they have submitted samples of work, they have adopted the Hayden automatic block machine in their plant, and their product is endorsed by the best architects and builders of their vicinity.

Omaha, Neb.—Special.—The Omaha Concrete Stone Co., 28th Ave. and Boyd St., advise us that they have a contract for erecting a $20,000 church, to be built entirely of cement blocks. This will be the first artificial stone building ever built in Omaha. The company wants an experienced first-class man who can make the sills, keystones and arches for doors and windows in the building. The company operates two Frost machines, made by the Frost Concrete Stone Co., of Waterloo, Ia.

Jackson, Mich.—The Hartwick Machine Co. has been incorporated with a capital stock of $21,000, to manufacture and sell machinery. The chief machine is one for mixing concrete, on which a patent is pending. The plant is located in the Knickerbocker building, on Park Ave. The stockholders are George Schiffler, George McKeel, E. E. Hartwick and J. W. Hartwick.

PURCHASE OF MATERIALS.

St. Paul, Minn.—Special.—W. A. Hammond, 621 Germania Life Bldg., desires to purchase cement.

Montreal, Canada — Special — Alcide Chausse, city hall, advises us that he desires to purchase concrete and concrete blocks for building.

Meredith, N. H.—Special.—Bartlett & Smith desire to purchase cement.

Auburn, N. Y.—Special.—C. E. Emerick, 16 Seward Blk., advises us that he is in the market for Portland cement.

Flushing, Ohio—Special—A. H. Binus, mfr. of concrete blocks, desires to purchase lumber and builders' supplies.

Grinnell, Ia.—Special.—George Sampson, 717 East St., desires to purchase cements, limes and plaster.

Brigham, Utah—Special—N. P. Anderson, cy. engr., advises us that he is in the market for cement.

Chester, N. Y.—Special.—W. D. Miller is in the market for cement and stone.

Lawrence, Mass.—Special.—John Keegan, 246 Oak St., advises us that he desires to purchase cement and lime.

Toledo, Ohio—Special—Marston & Gould, 221 Law Bldg., desire to purchase cement and timber.

Zanesville, Ohio—Special—S. W. Hoffman, Jewett Drive, advises us that he is in the market for cement.

Vancouver, Wash.—Special.—J. W. Wentworth desires to purchase cements.

Portsmouth, Va.—Special.—J. E. Hanrahan, 410 County St., desires to purchase bricks, lime, cement and broken stone.

Independence, Kans.—Special.—F. D. Brewster desires to purchase cement and lime.

Colorado Springs, Colo.—Special.—The Colorado Brick & Artificial Stone Co. is in the market for lime, sand and cement.

Fulton, Mo.—Special.—Francis Boand desires to purchase Portland cement.

Far Hills, N. J.—Special.—Thomas Noore is in the market for cement.

Buffalo, N. Y.—Special.—William Hurley, 426 Marilla St., advises us that he is in the market for cement, etc.

Cherryvale, Kans.—Special.—Geo. Behner, 732 Neosho St., is in the market for cement, plastering and brick work.

Louisville, Ga.—Special.—J. F. Brown is in the market for cement.

Cedar Rapids, Ia.—Special.—J. J. Snouffer, Jr., 315 Granby Bldg., is in the market for blasting powder, dynamite, fuse and caps.

Lincoln, Neb.—Special.—Walsh Bros., 1241 O St., advises us that he desires to purchase cement, brick, crushed stone, sand, plaster and lime.

Little Rock, Ark.—Special.—Ed Hill, 2418 W. 16th St., is in the market for cement.

Riverside, Cal.—Special.—Zeno DeMoss desires to purchase cement, lime and plaster.

Elmira, N. Y.—Special.—James Johnson, 1319 Lake St., desires to purchase cement.

Orange, Mass.—Special.—Geo. R. Carpenter, 24 Clifton St., advises us that he desires to purchase coal tar, concrete, pitch, cement and sewer pipe.

Bristol, Tenn.—Special.—Robt. Burrow advises us that he is in the market for quite a lot of cement.

Port Morien, N. S.—Special.—George B. Burchell desires to purchase hard pine and cement.

PURCHASE OF MACHINERY.

Sleepy Eye, Minn.—Special.—Fred C. Koehne, of the Sleepy Eye Paving Works, 204 E. Main St., advises us that he is about to purchase a block machine and would like to receive catalogues and cuts of different makes.

Montreal, Que.—Special.—T. A. Morrison & Co., 204 St. James St., desires to purchase road machinery and fire apparatus.

Keokuk, Ia.—Special.—Peter D. Kennedy, 1213 Exchange St., desires to purchase finishing tools.

Paris, Ill.—Special.—Morrissey & Porter advise us that they are in the market for machinery and tools for street paving, good roads and sewers.

Bound Brook, N. J.—Special.—Runyan Field desires to purchase cement block machinery.

Port Morien, N. S.—Special.—George B. Burchell advises us that he is in the market for machinery and tools for coal mining and breakwater construction.

New York City—Special—Thos. B. McIntire, 1011 E. 15th St., desires to purchase concrete block machines.

Laredo, Tex.—Special.—M. S. Ryan advises us that he is in the market for tools and machinery for steel construction.

St. Louis, Mo.—Special.—The Parker-Washington Co. advises us that they are in the market for a good first-class 7 to 10-ton asphalt steam roller.

Indianapolis, Ind.—Special.—M. K. Alexander, 1623 N. New Jersey St., desires to purchase a concrete block machine.

Elmira, N. Y.—Special.—James Johnson, 1319 Lake St., desires to purchase a mixer.

Orange, Mass.—Special.—Geo. B. Carpenter, 24 Clifton St., advises us that he is interested as a possible purchaser in concreting tools and steam drills.

Little Rock, Ark.—Special.—Ed Hill, 2418 W. 16th St., desires to purchase stone working machinery and concrete tools.

Riverside, Cal.—Special.—Zena DeMoss is interested as a possible purchaser in cement tools.

St. Louis, Mo.—Special.—Nick Lamb, Jr., Winner St., desires to purchase machinery and tools for quarrying and contracting.

Cedar Rapids, Ia.—Special.—J. J. Snouffer, Jr., 315 Granby Bldg., advises us that he desires to purchase a stone crusher, concrete mixer, steam roller and belting.

Lincoln, Neb.—Special.—Walsh Bros., 1241 O St., advises us that he is possible purchaser of machinery for making cement blocks and tools for laying sidewalks.

Louisville, Ga.—Special.—J. F. Brown desires to purchase machinery for the manufacture of cement building blocks.

Little Rock, Ark.—Special.—Wm. Haman, 2017 W. 6th St., advises us that he desires to purchase machinery and tools for concrete work, sidewalks and curbing.

Omaha, Neb.—Special.—Sunderland Bros. Co., 1608 Harney St., advise us that they are interested as possible purchasers in machinery and tools for stone quarrying and crushing.

Clarksburg, W. Va.—Special.—Percy Limeir, 164 N. Coal St., desires to purchase a concrete mixer and cement tools.

Colorado Springs, Colo.—Special.—The Colorado Brick & Artificial Stone Co. advise us that they are interested as possible purchasers in mixing and conveying machinery, hard presses, etc.

Philadelphia, Pa.—Special.—Charles I. Moore, Jr., 1238 W. College Ave., desires to purchase machinery and tools for cement work, building and quarrying work.

Fulton, Mo.—Special.—Francis Bond is in the market for machinery and tools for building blocks and a rock crusher.

Buffalo, N. Y.—Special.—Wm. Hurley, 426 Marilla St., is in the market for machinery for hollow concrete blocks.

Independence, Kans.—Special.—F. D. Brewster desires to purchase concrete mixers, mortar mixers and cement block machines.

Rushville, Ill.—Special.—Francis C. Bagby is in the market for surveying instruments.

Portsmouth, Va.—Special.—J. E. Hanrahan, 410 County St., advises us that he is in the market for finishing tools for granolithic work and concrete work.

Zanesville, Ohio—Special—S. W. Hoffman, Jewett Drive, desires to purchase cement machinery and tools and building block machinery.

Union City, Pa.—Special.—W. O. Gates, chinery and tools for concrete foundations and building blocks.

Clyde, N. Y.—Special.—E. W. Dickie, contr. and dealer in mason supplies, desires to purchase machinery and tools for concrete block and brick.

Hampton, Ia.—Special.—A. W. Barker, box 621, advises us that he is in the market for machinery and tools for sidewalks and cement work.

St. Marys, Ohio—Special—S. E. Sowers desires to purchase tools for sidewalks, curb and gutter.

Lawrence, Mass.—Special.—John Keegan, 246 Oak St., desires to purchase tools for mason work.

Toledo, Ohio—Special—Marston & Gould, 221 Law Bldg., advise us that they desire to purchase concrete mixers and block machines.

Chester, N. Y.—Special.—D. W. Miller is in the market for machinery and tools for general contracting.

Brigham, Utah—Special—N. P. Anderson, cy. engr., desires to purchase valves for tubes in dams, and hoistings and gearings for same.

Everett, Wash.—Special.—C. A. Missimer, 2118 Rucker Ave., advises us that he desires to purchase logging and railroad outfits, engines and cars.

Cortland, N. Y.—Special.—S. P. Hull desires to purchase machinery for concrete construction.

Baker City, Ore.—Special.—T. K. Clark, 233 Bridge St., desires to purchase machinery for hollow cement blocks, ornamental stone and fence posts.

East Orange, N. J.—Special.—L. W. Cyphers, 168 Dodd St., advises us that he is in the market for machinery for making posts, bridges, sidewalks, sewer pipe, etc., cement in general, and conduits and machinery.

Portage, Wis.—Special.—P. C. Vanness desires to purchase a mixer and block mold.

Philadelphia, Pa.—Special.—The Filbert Paving & Const. Co., 818 Pennsylvania Bldg., advise us that they are interested as possible purchasers in machinery and tools for all kinds of concrete and asphalt work, grading, etc.

Glenwood, Ia.—Special.—Seth Dean desires to purchase machinery and tools for drainage and road improvement.

Auburn, N. Y.—Special.—C. E. Emerick, 16 Seward Blk., is in the market for tools for cement walks and pavements, tile mantles, etc.

Grinnell, Ia.—Special.—George Sampson, 717 East St., desires to purchase a concrete mixer.

Napa, Cal.—Special.—H. W. Wing desires to purchase machinery and tools for bridge work, stone and cement work.

Cleburne, Tex.—Special.—C. W. Henry, box 305, desires to know where he can obtain the Raebeor & McDonald make of cement sidewalk tools.

Adrian, Mich.—Special.—A. P. Southworth is in the market for machinery and tools for paving, sewers and concrete.

St. Paul, Minn.—Special.—W. A. Hammond, 621 Germania Life Bldg., desires to purchase cement block machinery.

Rensselaer, N. Y.—Special.—Chas. S. Finkle, 1506 Broadway, is in the market for concrete hollow block machinery.

HEAT, LIGHT AND POWER.

Harrisburg, Pa.—Notice was filed in the state department August 7 of the merger and consolidation of fifteen electric light and gas companies in Luzerne county.

Cleveland, Ohio—The Beam Engineering Co. has been incorporated to operate, buy, sell, equip and give reports on both the financial and physical condition of gas, electric light, street railway and waterworks plants, by H. A. Blythe, E. E. Beam and C. E. F. Ahlin.

New electric light and gas companies have been incorporated as follows:

Anderson, S. C.—Hatton's Ford Power Co.: Maj. Augustine T. Smythe, of Charleston, and F. G. Brown and R. S. Ligon, of this city.

Fond du Lac, Wis.—Independent Light, Heat & Power Co.: Robert R. Freeman, G. R. Hoffman, Frank D. Fulton.

St. Augustine, Fla.—St. John's Light & Power Co.

Denver, Colo.—Miller-Hoppin Electric Co.: J. B. Hoppin, F. F. Miller, J. S. Bodwen.

Jasonville, Ind.—Jasonville Electric Co.—James H. Persons, prest.

Camp Hill, Pa.—Camp Hill Illuminating Gas Co.: Naudain Hamilton, George Nauman, R. C. Neal, Jr., all of Harrisburg.

Petersburg, Pa.—Petersburg Light & Power Co.

SEWER PIPE.

Minneapolis, Minn.—The Miracle Pressed Stone Co., which manufactures the Miracle concrete building blocks, is meeting with great success with its cement sewer pipe molds.

Springfield, Minn.—A. C. Ochs contemplates making additions and improvements to his brick plant that will enable him to make drain tile and sewer pipe next season.

MISCELLANEOUS.

Groton, N. Y.—Special.—The entire manufacturing plant of the American Road Roller Co., consisting of its lands, buildings, machinery, tools, stock and material on hand, will be sold at public auction September 14. George S. Tarbell, referee in bankruptcy, Trust Co. Bldg., Ithaca; Frank P. Hakes, trustee American Road Roller Co., Groton.

Patents of Interest to Municipalities and to Contractors.

774,422. Nov. 8, 1904. Syphon. John F. Harrigan, Boston, Mass.

774,871. Nov. 15, 1904. Refuse Crematory. Charles Force, Chicago, Ill.

774,877. Nov. 15, 1904. Sheet Piling. James N. Hatch, Chicago, Ill.

774,901. Nov. 15, 1904. Levee Protector and Process of Making Same. Frank V. Wright, San Francisco, Cal.

774,936. Nov. 15, 1904. Furnace for Burning Refuse. Thomas C. Clark, Cambridge, O.

775,061. Nov. 15, 1904. Garbage Box or Receptacle. Herman Breyer, Chicago, Ill.

775,163. Nov. 15, 1904. Street Sweeper. Alvin Brown, Plainfield, Ill.

775,486. Nov. 22, 1904. Paving Block or Set for Use Along the Rails of Tramways. Johann G. Wolf, Gratz, Austria-Hungary.

775,569. Nov. 22, 1904. Street-Sweeper. August Larson, Chicago, Ill.

IMPROVEMENT AND CONTRACTING NEWS

PAVING.

Washington, D. C.—An amendment was made to the police regulations August 15, making it an offense to overload beer wagons or other heavy trucks. The amendment is for the purpose of preventing undue wear and tear on the asphalt streets of this city.

Washington, D. C.—The forest service of the Department of Agriculture has announced that it has taken up the study of woods for special uses, and experiments will be conducted particularly to secure a wood for street paving which will prove lasting.

Logansport, Ind.—Injunction proceedings were filed against the Western Construction Co., August 3, to prevent it from proceeding with the improvement of North street with bitulithic. The injunction will prevent the company from going ahead with the work until after September 4, when the case is set for a hearing.

CONTEMPLATED WORK.

Iowa City, Ia.—Brown street may be paved.

Orange, N. J.—The question of repaving Main street will again be agitated.

Mt. Vernon, Ia.—Council has appropriated $1,000 for street improvements.

Edwardsville, Ill.—Contracts will be let soon for brick paving and sewers.

Upper Alton, Ill.—Contracts will be let soon for about two miles of sidewalks.

Centralia, Ill.—A resolution has been adopted to pave thirty-two blocks of streets.

Niles, O.—Ordinances have been prepared for paving and improving Park avenue and Main street.

Lima, O.—Ordinances have been passed for paving North and South Main street. O. J. Rose, cy. engr.

Fernandina, Fla.—The question of issuing bonds for paving Center street is being considered.

Rensselaer, N. Y.—The macadamizing of Riverside avenue, Lower Rensselaer, is contemplated.

Fremont, Neb.—An ordinance was passed August 15 providing for the paving of Fifth street. Mayor Wolz.

Peoria, Ill.—The property owners on Hamilton street want that thoroughfare repaved with brick.

Plainville, Conn.—This town has appropriated $9,000 for new stone roads on New Britain road and West Main street.

Jacksonville, Fla.—The question of issuing bonds for paving, sewers and water works will be voted on.

Altoona, Pa.—A petition is being circulated asking that Thirteenth street, between Ninth and Second avenues, be paved.

Hot Springs, Ark.—This city contemplates paving a number of streets soon. Samuel Hamblen, cy. engr.

Lorain, O.—The property owners on Washington street, from West Erie avenue to Lake street, have petitioned for paving.

Cincinnati, O.—A resolution has been adopted for paving Ninth street, from Freeman to McLean avenues, with wooden blocks.

Florence, Ala.—New bids will be considered at the September meeting of the Council for improving College street.

Pensacola, Fla.—A special election will be held April 22 to vote on the issue of bonds for paving, sewers and water works.

Redding, Cal.—The question of issuing $130,000 bonds for street improvements and sewers may be voted on again. Mayor Merrill.

Grand Rapids, Mich.—L. W. Anderson, cy. engr., has recommended that East Bridge street hill be paved with bituminous macadam.

Kansas City, Mo.—The Board of Public Works has adopted a resolution to allow competition in asphalt paving hereafter.

Houghton, Mich.—College avenue will be paved its entire length with creosoted wood blocks. G. L. Clausen, vil. engr.

Montgomery, Ala.—Council has passed ordinances providing for the construction of sidewalks on a number of streets.

Huntsville, Ala.—The City Council has asked the County Commissioners to defray a third of the expense of paving Court Square with vitrified brick.

Lebanon, Ind.—The bids received recently for 8,975 sq. yds. of bitulithic paving and 1,030 sq. ft. of cement sidewalks were rejected. Edmund Connor, cy. clk.

Springfield, O.—Resolutions have been passed providing for grading and macadamizing Fremont avenue and grading and graveling Factory street. Chas. J. Bowlus, mayor.

Kewanee, Ill.—An ordinance was approved August 8 providing for the construction of a concrete sidewalk on First street. Samuel Bradbury, mayor; Chas. E. Mulligan, cy. clk.

Trenton, O.—Council is considering a petition from the property owners on Third street, asking for the establishment of a grade for curbing, gutters and cement walks.

Harrison, N. J.—The improvement of Davis avenue, from Harrison avenue, this town, to Midland avenue, Arlington, is being discussed by joint committees from this town and Kearny.

Urbana, O.—A resolution has been passed to construct concrete and sawed sandstone sidewalks on Miami street, from Monument Square to the Big Four Railroad. J. G. Wallace, Jr., clk.

Omaha, Neb.—A resolution has been adopted ordering that hereafter, when streets are paved, the street railway company shall pave between its rails with vitrified brick. Ordinances have been passed for paving Thirty-seventh street, from Farnam to Dodge, with asphalt; Thirty-third street with brick block, Twentieth and Howard streets with asphalt.

Racine, Wis.—Asphalt paving is proposed for Lake avenue.

Waynesburg, Pa.—This town voted, August 22, to issue $15,000 bonds for street paving.

Dubuque, Ia.—Bids will be asked soon for macadamizing Pine street, from Twenty-third to Twenty-sixth. Cy. clk.

Laconia, N. H.—Council has appropriated $5,000 for paving Elm and Water streets. F. G. Berry, cy. engr.

St. Paul, Minn.—The Board of Public Works has reported favorably on the proposed paving of Fillmore avenue.

Altoona, Pa.—Ordinances are being prepared for a large amount of vitrified brick paving. Harvey Linton, cy. engr.

Covington, Ky.—An ordinance has been passed for paving Eighteenth street, from Garrard to Edward, with brick, with cement curb and gutters.

Everett, Mass.—Bids will be asked soon for constructing 8,000 sq. yds. of bitulithic paving on Main street. C. Harrison, cy. engr.

Oregon City, Ore.—City Council will ask bids soon for constructing two blocks of macadam paving, with plank walks and concrete curbs, on Fifth street. E. P. Rands, cy. engr.

San Antonio, Tex.—The citizens in the central part of the city are forming a district for the purpose of paving with brick or asphalt about 70,000 sq. yds. of streets. John D. Rullman, cy. engr.

Vernon, Conn.—P. B. Leonard, Paul Brache and J. H. Zimmerman, selectmen, have called a special meeting for the voters of this town, to see if they will appropriate a sum of money for the construction of macadam roads.

Johnstown, N. Y.—Common Council has declared its intention of paving Perry, North and South Market streets, with asphalt block and West Montgomery with macadam. Further action will be taken September 4 toward adopting plans and specifications.

Findlay, O.—The residents on Center street have petitioned for brick paving from Blanchard street to McManus avenue. The residents on Baldwin and Lima avenues have also petitioned for brick paving, and a resolution has been adopted for paving Shinkle street, from Main Cross street to the river, with brick.

CONTRACTS TO BE LET.

Iola, Kans.—Bids are asked until September 7 for curbing, paving and grading. Geo. Myers, cy. engr.

Wilmington, Del.—Bids are asked until September 5 for building a macadam road. Francis A. Price, comr.

Bisbee, Ariz.—Sealed bids are asked until September 5 for paving Main street and Brewery avenue. C. W. Hicks, cy. clk.

Cincinnati, O.—Bids are asked until September 6 for improving a portion of Foley's road. E. L. Lewis, co. audt.

Norwalk, O.—Bids are asked until September 5 for paving East Main street with brick. T. P. Kellogg, clk. B. P. S.

Toledo, O.—Bids are asked until September 5 for paving Felt street and Parkwood avenue. Harry S. Jones, sec. B. P. S.

Rockville, Ind.—Sealed bids are asked until September 4 for constructing certain gravel roads. T. A. Garrard, chmn. co. comrs.

Decatur, Ind.—Sealed bids are asked until September 4 for constructing the French twp. central gravel road. C. D. Lewton, co. audt.

St. Paul, Minn.—Sealed bids are asked until September 4 for grading and improving East Town Line road. Edw. G. Krahmer, co. audt.

Steelton, Pa.—Bids are asked until October 4 for paving Front street with wooden blocks, vitrified brick and asphalt. Council.

Cincinnati, O.—Sealed bids are asked until September 6 for paving Fairfax avenue with bitulithic. Geo. F. Holmes, clk. B. P. S.

Shelbina, Mo.—Bids are asked until September 10 for constructing about 75,000 sq. ft. of cement and granitoid walk. Mississippi Valley & Gulf Ry. Co.

Jasper, Ind.—Sealed bids are asked until September 4 for grading, draining and paving with stone about 3 miles of road. M. A. Sweeney, co. audt.

Bay City, Mich.—Sealed bids are asked until September 4 for grading, draining and paving with vitrified brick Woodside avenue. G. Hine, chmn. B. P. W.

Providence, R. I.—Sealed bids are asked until September 6 for constructing State highways in several towns. John H. Edwards, chmn. State Bd. Pub. Rds.

Rapid City, S. Dak.—Sealed bids are asked until September 5 for building cement sidewalks on north and west sides of courthouse square. Robt. Rudesill, co. audt.

Hartford, Conn.—Sealed bids are asked until September 2 for grading, flag walks, curbing, etc., at the State Normal School grounds. State B. of Education.

Washington, Ind.—Sealed bids are asked until September 9 for constructing the extension system of gravel and rock roads. John G. Shanks, chmn. co. comrs., Thos. Nugent, co. audt.

Miller, S. Dak.—Bids are asked until September 5 for constructing a cement sidewalk on east and south sides of courthouse block and curbing the south side. W. E. Morrow, co. audt.

Harrisburg, Pa.—Bids are asked until September 2 for constructing 11,250 ft. of road in East Vincent twp. and 5,445 ft. in Westtown twp. Jos. W. Hunter, State Highway Comr.

Janesville, Wis.—Sealed bids are asked until September 11 for paving Milwaukee avenue, from East to Harrison streets, with cement curb and gutter and brick crosswalks. J. F. Hutchinson, chmn. st. asst. com.

Columbus, O.—Sealed bids are asked until September 5 for macadamizing the roadway of the west approach to the Fifth avenue bridge, over the Olentangy river, in Franklin and Clinton twps. L. E. Jones, co. audt.

South Orange, N. J.—Sealed bids are asked until September 11 for constructing about 2,700 ft. of concrete sidewalks on Maplewood avenue. Baker street and Ridgewood road. H. Stacy Smith, chmn. rd. com. of South Orange twp.

Crookston, Minn.—Bids are asked until September 12 for 2,709 sq. yds. of creosoted block paving on East Robert street, between Broadway and Jerome addition bridge. The work amounts to 2,709 sq. yds. J. E. Carroll, cy. engr.

Bellevue, Pa.—Sealed bids are asked until September 5 for grading, curbing and paving Woodlawn avenue and grading and curbing Starr avenue. J. M. Simeral, clk. coun., 69 Harrison avenue; John McBridge, boro engr., 46 Fidelity Building, Pittsburg.

Indianapolis, Ind.—Sealed bids are asked until September 1 for paving an alley with brick; grading and graveling Columbia avenue, from Twenty-third to Twenty-fifth streets; building cement sidewalks on Temple avenue, from Tenth

to Eleventh streets. M. A. Downing, chmn. B. P. W.

Memphis, Tenn.—Sealed bids are asked until September 7 for paving Main street between Poplar and Calhoun streets, consisting of 21,000 sq. yds. of asphalt; tearing up and relaying 21,000 sq. yds. of old granite block; tearing up and hauling 24,000 sq. yds. of old brick paving; laying 3,000 sq. yds. of new granite blocks. J. J. Williams, mayor.

Harrison, N. J.—Sealed bids are asked until September 5 for paving Hamilton street, from John street to Davis avenue, with telford, involving the following: 7,600 lin. ft. 12-in. paving, 2,200 sq. ft. trap rock or brick gutters, 3,200 lin. ft. new curb, 1,600 lin. ft. old curb reset, 4 sets corners reset, 14 manhole heads readjusted, 7 basin heads reset, 600 sq. ft. new bridge stone. C. J. Witt, chmn. com. on sts.; B. J. Walsh, town clk.

East Palestine, O.—Bids are asked until September 4 for 14,111 sq. yds. of brick paving.

Dayton, O.—Bids are asked until September 6 for 2,700 sq. yds. of brick paving. F. M. Turner, cy. engr.

Brownstown, Ind.—Bids are asked until September 5 for constructing gravel roads. H. W. Wacker, co. audt.

Willoughby, O.—Bids are asked until September 18 for paving Erie street with brick and curbing. C. C. Jenkins, vil. clk.

Ottawa, O.—O. C. Talbot, co. surv., says that contracts will be let September 16 for 10 1-4 miles of stone road.

Sullivan, Ind.—Bids are asked until September 1 for constructing three gravel or macadam roads in Curry twp. E. E. Russell, co. audt.

Bayonne, N. J.—Bids are asked until September 5 for constructing 1,547 sq. yds. of brick paving on Dodge street. W. C. Hamilton, cy. clk.

Stoughton, Wis.—Sealed bids are asked until September 2 for constructing a standard sidewalk on Main street. W. H. Linderud, clk. st. assmt. com.

Crookston, Minn.—Sealed bids are asked until September 12 for curbing, draining and paving East Robert street with creosoted pine blocks. A. M. Childs, cy. clk.

Mercer, Pa.—Bids are asked until September 6 for furnishing 400,000 vitrified brick, and for constructing 4,700 ft. of cement curbing. J. M. Campbell, cy. clk.

Beloit, Wis.—Sealed bids are asked until September 2 for placing rubble upon highways and for graveling thirty rods on the highway. A. C. Powers, supvr.

Greencastle, Ind.—Bids are asked until September 4 for constructing 11,466 ft. of macadamized roads in Greencastle twp. Samuel H. Judy, chmn. co. comrs.

Council Bluffs, Ia.—Sealed bids are asked until 12 m., September 4, for constructing 58,000 sq. yds. of artificial stone sidewalk. L. Zurmuehlen, Jr., cy. clk.

Centerville, Ind.—Sealed bids are asked until 7 p. m., September 1, for constructing cement sidewalks and combination curb and gutter. Wilbert A. Bertsch, clk.

Crawfordsville, Ind.—Sealed bids are asked until September 4 for constructing a cement sidewalk on Parke avenue, from Market to Binford street. H. B. Hulett, cy. clk.

Greensburg, Pa.—Sealed bids are asked until September 4 for grading, curbing and paving with vitrified brick 1,244 ft. of East Pittsburg street. Warren Mitchell, boro engr.

Lancaster, Pa.—Bids are asked until September 4 for removing about 7,150 sq. yds. of Belgian blocks, and for substituting therefor asphalt, wooden blocks or other noiseless paving material on Center Square and North Queen street. J. H. Rathfon, cy. compt.

Brooklyn, N. Y.—Bids are asked until September 7 for 11,372 sq. yds. of asphalt paving, 5,947 ft. new curb, 6,515 ft. new curb set in concrete, 46,225 sq. ft. cement sidewalks, 2,004 cub. yds. concrete and 8,732 cub. yds. earth excavation. Martin W. Littleton, boro prest.

CONTRACTS AWARDED.

Sacred Heart, Minn.—The contract for building sidewalks was awarded to Wiglund & Olson.

Tampa, Fla.—W. H. Kendrick was awarded the contract for street paving for about $600,000.

Albert Lea, Minn.—The contract for curbing Water St. was awarded to D. M. Dominick, for $2,347.

Glassport, Pa.—The contract for improving Vermont Ave. was awarded to D. V. Ault & Co., for $18,420.

Duluth, Minn.—The contract for paving W. Superior St. with macadam was awarded to Hugh Steele, for $79,305.

Salt Lake City, Utah—P. J. Moran was awarded the contract for paving Brigham St. from 7th East to 10th East.

St. Albans, Vt.—The contract for building new side and cross walks was awarded to A. L. Adams, of Rutland.

Dallas, Texas—The contract for 12,000 sq. yds. of bitulithic paving was awarded to the Southern Bitulithic Co.

Red Lodge, Mont.—The Two Miracles Concrete Co. of Minneapolis and Helena are constructing cement sidewalks here.

Boone, Iowa—The contract for paving 7th and Story Sts. with brick was awarded to M. Ford, of Cedar Rapids, for $12,540.

Somerville, Mass.—Special.—Warren Brothers Company has been awarded the contract for 5,000 sq. yds. of bitulithic paving.

Omaha, Neb.—The contract for paving 24th St. from A to Q Sts., was awarded to Parks, Johnson & Parks, at $1.95 a sq. yd.

Bay City, Mich.—The contract for paving Washington St. viaduct with brick was awarded, August 12, to W. J. Meagher, for $6,567.

Waterbury, Conn.—The contract for paving N. Willow St., from W. Main to Grove St., was awarded to Edward McManus, for $5,242.50.

Logansport, Ind.—Special.—The Western Construction Co. has been awarded a contract for 22,000 sq. yds. of bitulithic paving here.

Slayton, Minn.—The contract for 9,380 sq. ft. of cement walk and 500 ft. of alley crossings was awarded to Fowler & Pay, of Mankato.

Tacoma, Wash.—The contract for constructing cement sidewalks in Old Town was awarded to the George Milton Salvage Co., for $13,360.

Ilion, N. Y.—Alonzo Schaupp was awarded the contract, August 10, for paving E. Main, 1st and 2d Sts. with macadam, at 76 cts. a sq. yd.

Salt Lake City, Utah—The contract for paving Market St. with Utah rock asphalt was awarded, August 14, to the Palmer-Tate Co., for $10,799.90.

Bluffton, Ind.—The Hoosier Const. Co., of Indianapolis, was awarded the contract, August 17, for six blocks of asphalt paving, at $1.98 a sq. yd.

Hollidaysburg, Pa. — Special. — The Standard Bitulithic Co. of Philadelphia, Pa., has been awarded a contract for 10,000 sq. yds. of bitulithic.

Auburn, N. Y.—A contract for 11,880

sq. yds. of bitulithic has been awarded to Brayer Bros. of this city.

Bloomington, Ill.—The Crescent Stone Co. of Peoria was awarded the contract, August 11, for paving Seminary Ave. and Lee, Oak, Olive and Vale Sts.

Centerville, Iowa—Special—The contract for brick paving districts Nos. 1 and 2 was awarded to the Davenport Construction Co., of Davenport, for $105,-935.39.

Seymour, Conn.—The contract for constructing 4,664 1-2 ft. of state highway was awarded, August 16, to Elbert N. Clark, of Milford, at 73 cts. a lin. ft.

St. Paul, Minn.—The contract for paving Maria Ave., from E. 7th to Plum Sts., was awarded, August 15, to Fielding & Shepley. Sandstone will be the material used.

Ottumwa, Iowa—Magden & Sheely, of Des Moines, secured the contract for paving Washington St., from 4th to Court, with brick on concrete, at $1.63 a sq. yd.

Irvington, N. J.—A contract has been awarded the Warren Brothers Co. for 11,-700 sq. yds. of bitulithic pavement.

Mankato, Minn.—The Coughlan Cement Const. Co. was awarded the contract, August 17, for curbing and guttering Clark St., from Byron to Prospect, at 80 cts. a lin. ft.

Mauch Chunk, Pa.—Special.—The Standard Bitulithic Company of Philadelphia, Pa., has been awarded a contract for 15,000 sq. yds. of bitulithic pavement.

Dayton, Ohio—The contract for paving W. 5th St., from the river bridge to Broadway, with Hocking Valley block, was awarded, August 10, to M. O'Herron & Co., at 94 cts. a sq. yd.

Milwaukee, Wis.—The contract for paving Mitchell St., from 1st Ave. to Hanover St., with brick was awarded, August 9, to the Badger Const. Co., at $1.68 a sq. yd.

Danville, Ind.—The contract for constructing the Frazee road, on the Hendricks-Marion county line, was awarded to the Boone County Const. Co., of Lebanon, for $6,467.

Shreveport, La.—A contract for 25,000 sq. yds. of bitulithic pavement has been awarded to the Southern Bitulithic Co.

London, Ont.—Special.—The Warren Bituminous Paving Co. of Toronto, Ont., will pave Richmond St. with bitulithic, the contract having been awarded.

Asheville, N. C.—Three streets will be paved with bitulithic, a contract for 15,-000 sq. yds. having been awarded to the Warren Brothers Co.

Cambridge, Mass.—Special.—A contract for 15,000 sq. yds. of bitulithic, to be laid in Cambridge St., has been awarded to the Warren Brothers Co.

Meadville, Pa.—The contract for paving Chestnut St., from Market St. to Diamond Park, with Park paving block was awarded, August 11, to John Swan, Jr., of Allegheny, Pa. Ohio quarry stone curbing will be used.

Indianapolis, Ind.—Special.—The Hoosier Const. Co. has been awarded a contract for 9,000 sq. yds. of bitulithic paving on Fall Creek Boulevard, and 10,200 sq. yds. on Northwestern Ave.

Waterbury, Conn.—Special.—Main and W. Willow Sts. will be paved with bitulithic at $2.30 per sq. yd. The contract has been awarded to Warren Brothers Co., of Boston, Mass.

Ottawa, Ont.—Special.—The Warren Bituminous Paving Co. of Toronto, Ont., has been awarded a contract for 12,000 sq. yds. of the bitulithic pavement, to be laid in Wellington Ave.

Seattle, Wash.—S. Normile, of this city, was awarded the contract for grading Roy and other streets, for $6,947. The Sparger Concrete Co. secured the contract for building concrete walks on Yeslor Way, for $2,991.

Dallas, Texas—The bitulithic pavement has been adopted by Dallas, Texas, and a contract for 12,000 sq. yds. has been awarded to the Southern Bitulithic Co.

Ottawa, Ont.—Special.—The Warren Bituminous Paving Co. of Toronto, Ont., has been awarded contracts aggregating 12,300 sq. yds. of bitulithic, to be laid in Pape Ave., Bain Ave. and Blecker St.

Birmingham, Ala.—Dunn & Lallande secured the contract for street improvements under ordinance No. 275, for $7,000, and the Crockett Paving Co. the contract for improvements under ordinances 247, 270, 271, 273 and 274, for $4,654.

Milwaukee, Wis.—Special.—Jackson, Wells and Clayborne Sts. will be paved with bitulithic, a contract for 14,300 sq. yds. having been awarded to the Central Bitulithic Paving Co., of Detroit, Mich.

Boston, Mass.—Contracts for constructing sections of state highway were awarded August 17, as follows: Pittsfield, O. T. Benedict, of Pittsfield, $2,183; Westport, Lane Quarry Co., Hingham, $2,350; Charlton, R. F. Hudson, Melrose, $2,938; Quincy, Lane Quarry Co., $2,860.

Rochester, N. Y.—The contract for paving Shelter St. with Johnsonburg brick was annulled, August 17, and a new contract made with Chambers & Grady, in which Mack brick was named. F. A. Brotsch and Son was awarded the contract for paving Mead St. with Metropolitan brick, for $5,074.40.

Manchester, Iowa—Special—The Kimball Engrg. Co., of Davenport, engrs. in charge, advise us that the contract for paving parts of Franklin and Main Sts. in this city with Galesburg brick, was awarded to M. Ford, of Cedar Rapids, at $1.68 a sq. yd. and 29 cts. a lin. ft. for cement curb.

Iowa City, Ia.—Special.—The Barber Asphalt Co., defaulting its contract to lay Warren's bitulithic pavement, new bids were called for, and the contract was awarded to William Horrabin, of Iowa City, Ia., a licensee of Warren Brothers Company.

Kansas City, Mo.—Special.—Sixth St. viaduct approaches in Kansas City, Mo., will be paved with bitulithic and the bridge with Acme asphalt, aggregating 50,000 yds.; 36th St., 3,000 yds., the contract having been awarded to the Kansas Bitulithic Co.

Ironton, Ohio—Special—J. R. C. Brown, cy. engr., says that Matt A. Mulligan, who has the contract for paving S. 3d St., has begun work. The work involves 31,000 sq. yds. of brick paving on concrete foundation, Pioneer filler, cement curb and gutter, and will cost $58,000. The work is to be completed January 1, 1906.

Harrison, N. J.—Special.—Van Keuren & Son, of Harrison, N. J., under special license issued by the Warren Brothers Co. to responsible contractors to furnish the wearing surface of the bitulithic pavement delivered at plant, at $1.35 per sq. yd., has been awarded a contract for 6,480 sq. yds.

Wheeling, W. Va.—The contract for paving the National Pike, from Cecil St. to Elm Grove, was awarded to E. D. Garretson & Co., at 38 cts. a yd. for exca.; 48 cts. for filling; 11-2 cts. for filling joints; 14 cts. for hauling block; furnishing blocks, $13.60 per thousand. J. C. Shannon was awarded the contract for

excavating Shannon road at 21 cts. a cu. yd.

Concord, N. H.—Contracts for the construction of state highways have been awarded as follows: In Amherst, Osgood Const. Co., of Nashua; from Hollis to Soule, Dillingham & Co., Boston; Pembroke, to Lane Const. Corp., of Connecticut; Bristol, to Willis Gordon, of Franklin. The towns of Tilton, Hopkinton, Northwood and Chichester were given contracts to construct highways as they desired them.

Wilmington, Del.—The contract for constructing 7,500 sq. yds. of bitulithic paving was awarded to J. Merrick Horn, August 17, at $1.95 a sq. yd. The contract for 5,000 sq. yds. of asphalt paving was awarded, August 22, to the Filbert Paving & Const. Co., of Philadelphia, at $1.85 a sq. yd., with the understanding that if the directors of street and sewer department decide to lay an additional 25,000 sq. yds or more, the price will be about $1.80 a sq. yd.

Cincinnati, Ohio—Special—Contracts have been awarded for bitulithic in Cincinnati, to the Warren Brothers Co. and licensees, in the following streets: E. Court St., 5,500 sq. yds.; Washington Ave., 8,300 sq. yds.; Pike St., 4,300 sq. yds.; Prospect Place, 6,000 sq. yds.; Ringold St., 3,308 sq. yds.; Linwood Ave., 40,740 sq. yds.; McAllister St., 890 sq. yds.; Lawrence St., 625 sq. yds.; Pioneer St., 3,170 sq. yds.; Hapsburg St., 1,670 sq. yds.

Kalamazoo, Mich.—Special.—M. C. Taft, cy. engr., says the contract for about 11,000 sq. yds. of paving and 1,200 lin. ft. of combination curb and gutter, on W. Main St., was awarded August 7 to Roy Williams, of Connersville, Ind., at $1.82 a sq. yd., for Metropolitan brick on 6 in. Portland cement concrete foundation, with Pioneer asphalt filler; 50 cts. a lin. ft. for curb and gutter; 6 cts. for resetting retaining stone; 12 cts. for redressing and resetting retaining stone; 40 cts. a cu. yd. for extra exca.; 25 cts. a lin. ft. for street ry. stringer and filler.

SEWERS.

Port Arthur, Texas—The Port Arthur Sewer Co. has been incorporated to construct, operate and maintain sewers, by R. C. Holmes, G. M. Craig, R. H. Woodworth, C. A. Fisher and C. D. Stillman.

Harrisburg, Pa.—The Suburban Drainage Co. has been incorporated to construct a sewerage system in Susquehanna twp., by Lewis M. Neiffer, of this city; George G. Diefenderfer, of Orwigsburg; Edward Moeslein, Chas. A. Klemm, city.

CONTEMPLATED WORK.

Marion, Ia.—A sewerage system is contemplated.

Le Roy, Ill.—A sewerage system is contemplated.

Titusville, Pa.—A sewer in Martin St. is proposed.

Portsmouth, Ohio—A sewer in Robinson Ave. is proposed.

Ida Grove, Ia.—Plans are being prepared for a sewerage system.

Yankton, S. D.—Plans are being prepared for a sewer in an alley.

Springfield, Minn.—Council voted to construct 900 ft. of sewer.

Albert Lea, Minn.—Council voted to build a main sewer in Spring Lake Park.

Macon, Mo.—Plans for a sewerage system are being made by C. J. DuBois, cy. engr.

Pensacola, Fla.—This city voted August 22 to issue $250,000 bonds for a sewerage system.

Fort Smith, Ark.—The creation of a new sewer district in this city is contemplated.

Wenatchee, Wash.—Council has passed an ordinance to build sewers in districts Nos. 1 and 2.

Brookhaven, Miss.—The sanitary com. has recommended the construction of a sewerage system.

Muskogee, I. T.—The city voted to issue $100,000 bonds for sewerage and waterworks improvements.

Cedar Falls, Ia.—The construction of 5,300 ft. of sewer in Iowa and Walnut Sts. is proposed.

Durango, Colo.—Plans are being prapared for a sewerage system. W. H. Wigglesworth, cy. engr.

Marion, Ill.—Bonds have been sold for constructing a sewerage system and extending the water mains.

Bloomsburg, Pa.—Plans have been prepared for a 24-inch sewer in 5th St. Jas. C. Brown, town engr.

East St. Louis, Ill.—City Engr. Crocken has prepared plans for an outlet sewer system, to cost $758,000.

Ambler, Pa.—Council is considering a proposition from the Ambler Sewer Co. for building a sewerage system.

Lansing, Mich.—Estimates have been prepared for sewers in Larch and Sheridan Sts. H. A. Collar, cy. engr.

Norwalk, Ohio—A resolution has been passed to build a relief or overflow sewer in E. and W. Elm Sts. C. W. Anderson, mayor.

New Haven, Conn.—City Engr. Kelly will ask the bd. of ald. for an appropriation of $50,000 for building the State St. sewer overflow.

Port Huron, Mich.—W. W. Phillips, cy. engr., has recommended, according to press reports, two sewer systems for the 9th and 10th wards.

Rochelle, Ill.—Special.—The Iowa Engrg. Co., of Clinton, Ia., has been engaged to prepare plans, specifications for a sewerage system.

Gainesville, Fla.—Special.—This city has engaged Wm. W. Lyon, C. E. of Palatka, to design plans and supervise the construction of a sanitary sewer system.

Sandwich, Ill.—Special.—Plans, estimates and specifications for a complete sewer system will be prepared by the Iowa Engineering Co., of Clinton, Ia.

Covington, Ky.—This city will vote in November on the question of issuing $40,000 bonds for extending Williow Run sewer and for building sewers in 19th and Patton Sts.

Lake City, Fla.—Special.—Wm. M. Lyon, of Palatka, has been engaged to make surveys, design plans and supervise the construction of a sanitary sewer system for this city.

Prosser, Wash.—Aldermen McNeill, Kemp and Harris are investigating with a view to recommending the construction of a sewerage system at the first meeting to be held in September.

Crystal Falls, Mich.—Special.—This city has retained E. G. Bradbury, C. E. of Columbus, Ohio, to prepare plans for a complete sanitary and storm water sewer system. Construction will probably begin this fall.

CONTRACTS TO BE LET.

Spirit Lake, Ia.—Bids are asked until September 5 for excavation to open ditch No. 3. Co. audt.

Appleton, Wis.—Bids are asked until September 6 for building a sewer on State road. E. L. Williams, cy. clk.

Oshkosh, Wis.—Bids are asked until September 20 for sewers in Vinland, Lemmer, Spruce and Congress Sts. B. P. W.

Salem, Ohio—Sealed bids are asked until September 7 for building sewers. H. B. F. MacFarland, chmn. dist. comrs.

New Hampton, Ia.—Bids are asked until September 6 for building a sewer and sewage disposal plant. F. B. Strike, cy. clk.

Lebanon, Ind.—Bids are asked until September 11 for building 830 ft. of 8-in. vitrified pipe sewer. Edmund Connor, cy. clk.

Rhinelander, Wis.—Bids are asked until September 9 for building a sewer on Lincoln, Edgar and other streets. Gust Swedberg, cy. clk.

Delaware, Ohio—Bids are asked until September 7 for constructing a sewer pipe or tile drain across Webb and Lake Sts. F. D. King, clk. B. P. S.

Reading, Pa.—Sealed bids are asked until Sept. 14 for the extension of the house sewer system in districts Nos. 3 1-2, 4, 5, 6 and 11. B. P. W.

Newton, N. J.—Sealed bids are asked until September 2 for constructing 7 mis. of sewers and 2 sewage purification plants. Morris C. Siple, town clk.

Lawrence, Kans.—Bids are asked until September 4 for constructing 3,000 ft. of 12-in. main sewer, 950 ft. of 8-in. laterals, with Y's and flush tank. Cy. clk.

Brooklyn, N. Y.—Bids are asked until September 13 for constructing 7,640 ft. of 15 and 12-in. sewers, with 78 manholes, etc. Martin W. Littleton, boro prest.

Miami, Fla.—Sealed bids are asked until September 5 for constructing a main canal, 10 mis. long and 15 mis. of laterals. E. C. Dearborn, clk. bd. co. comrs.

Estherville, Ia.—Bids are asked until September 5 for constructing 7,735 ft. of 12-in. and 1,380 ft. of 8-in. drain in districts Nos. 4 and 14. C. C. Hamilton, co. audt.

Tacoma, Wash.—Sealed bids are asked until September 6 for constructing a septic sewage tank for the Edison school. Alfred Lister, secy. bd. directors Tacoma Sch. dist. No. 10.

Centerville, Ia.—Bids are asked until Sept. 5 for constructing 6,187 ft. of 8-in. and 1,000 ft. 12-in. sewer, with 36 manholes and 7 flush tanks. Iowa Engrg. Co., engrs., Clinton.

Boise City, Idaho—Bids are asked until September 9 for building 22,300 lin. ft. of 8-in. vitrified pipe sewers, 60 manholes, 15 flush tanks and 4 flush lines with settling basins. Jos. Beal, cy. clk.

Nevada, Mo.—Sealed bids are asked until September 12 for constructing 12,450 ft. of 15-in., 8,750 ft. 12-in. and 800 ft. 10-in. vitrified pipe sewer, with manholes, branches, etc. James M. Clack, cy. engr.

Owosso, Mich.—Bids are asked until September 6 for constructing 2,136 ft. of 10-in. and 1,116 ft. of 12-in. vitrified pipe sewer, and 312 ft. 12-in. c. i. pipe outlet, with 10 manholes, 2 flush tanks and 1 lamp hole. B. P. W.

Harrison, N. J.—Sealed bids are asked until September 5 for constructing 735 ft. 20-in and 157 ft. of 10-in. vitrified pipe sewer, 3 junction manholes, 4 manholes and 4 basins. Edward J. Rice, chmn. com.; B. P. Walsh, town clk.

Willoughby, Ohio—Bids are asked until September 11 for constructing 1,450 lin. ft. 24-in., 450 ft. 18-in., 875 ft. 15-in. and 500 ft. 12-in. storm sewers, 9 manholes, 16 catch basins, 12 ft. c. i. pipe and a concrete retaining wall, containing 10 cu. yds. of concrete. C. C. Jenkins, vil. clk.

Lexington, Ky.—Sealed bids are asked until September 13 for constructing 5,780 ft. 8-in., 3,350 ft. 10-in., 10,900 ft. 12-in., 2,900 ft. 18-in., 4,300 ft. 20-in., 7,000 ft. 24-in. and 5,400 ft. 5-in. pipe, with appurtenances for house connections, 115 manholes and 4 flush tanks. Thos. A. Combs, mayor.

CONTRACTS AWARDED.

Tampa, Fla.—Warren Bros. were awarded the contract for constructing sewers, for $70,000.

Rome, Ga.—L. J. Wagner has been awarded the contract for building a sanitary sewer system, for $5,000.

Nashville, Tenn.—J. A. Webb has been awarded the contract for constructing 2,179 ft. of sewer, for $5,264.

St. Louis, Mo.—Fred Hoffman & Co. secured the contract for building the Benton sewer No. 6, for $8,374.50.

Utica, N. Y.—The contract for constructing a big outlet sewer has been awarded to Besch & Beebe, for $170,527.90.

Painesville, Ohio——The contract for building sewers in Liberty and South Sts. was awarded to Kleinman & Battles, of Cleveland.

Webster, Mass.—The Geo. M. Byrne Co., of Boston, was awarded the contract for building a section of outfall sewer, 2,000 ft. in length.

London, Ohio—The contract for constructing the sewage disposal works has been sublet to D. E. Sullivan & Son, of Columbus, for $5,200.

Macon, Ga.—The contract for building 7.03 mis. of sewers in the annexed district was awarded to A. L. Patterson & Co., for $37,051.93.

Hopkinsville, Ky.—The contract for constructing a sewerage system was awarded by the Hopkinsville Sewerage Co. to Robertson & Gardner, of Paducah.

Steubenville, Ohio—The contract for constructing a sewer on Adams St. was awarded, August 21, to Stitt & Kunse, for $11,316.70; Logan St., Ferguson & Purcell, $8,195.

Grand Rapids, Mich.—The contract for constructing a concrete sewer 2 1-2 mis. in length was awarded to the National Construction Co., of South Bend, Ind., for $105,000.

Hiawatha, Kans.—Special.—The contract for building a lateral sewer No. 7 in district No. 2 was awarded, August 21, to H. A. Fairchilds, at 67 cts. a lin. ft.; manholes, $40; flush tanks, $60.

Allentown, Pa.—The contract for constructing a sewer in Liberty St. was awarded to George H. Hardney, at $1.25 for 20-in. and $1.10 for 18-in. pipe; manholes, $15; corner catch basins, $55 each; rock exca., $2.50.

Columbus, Ohio—The contract for constructing Jackson Pike sewer and crossover sewers in Sullivant Ave. and McDowell St., was awarded to C. T. McCracken & Co., of this city, for $54,962 for brick and $59,881 for brick and concrete.

WATER WORKS.

Youngstown, Ohio—The new filtration plant was put in operation August 2.

Newark, N. J.—Water was turned into the new Cedar Grove reservoir August 9.

Nashville, Tenn.—An opinion has been rendered the state board of equalization by Attorney General Chas. T. Cates, Jr.,

holding that it is within the province of the legislature to classify property for the purposes of taxation, and that the classification of the property of public service corporations, under the assessment law of 1903, is different from that provided by the act of 1887; that under existing law, the pipes, mains and rights of way of the water company are assessable as personal property and therefore assessable annually.

Trenton, N. J.—Vice-Chancellor Stevenson has signed an order restraining the Washington Water Co. from shutting off the water supply from the fire hydrants in the borough of Washington, N. J. The borough authorities secured the injunction. They object to the price of $800 a year charged by the water company for supplying the fire hydrants, claiming that it is excessive. The borough has refused to renew the contract on the old terms, and the water company threatens to cut off the supply.

CONTEMPLATED WORK.

DuQuoin, Ill.—This city has about decided to construct waterworks.

Youngstown, Ohio—The question of an adequate water supply is being considered.

St. Maries, Idaho—This city is considering two plans for constructing waterworks.

New Orleans, La.—The question of a new waterworks system for this city is being urged.

Johnson City, Tenn.—The question of a municipal waterworks system is being investigated.

Perham, Minn.—This town has voted to issue $15,000 bonds for extending the water mains.

South Framingham, Mass.—The extension of the water mains to Saxonville is proposed. Town clk.

Beaver Crossing, Neb.—This town will vote on the question of issuing bonds for a waterworks system.

New York City—Health Comr. Darlington recommends a filtration plant for this city at a cost of $17,000,000.

Pilot Rock, Ore.—This city contemplates engaging an engineer to estimate the cost of constructing a new waterworks system.

Ashland, Pa.—This borough voted to increase its debt $12,000 for the purpose of increasing the water supply at the west end of town.

The question of constructing waterworks is contemplated at the following places: Wilmington, N. C.; Edinburg, Va.; Lehi, Utah; Swansea, Ill.

Somerville, N. J.—The citizens of this place, Bound Brook and Plainfield and North Plainfield are talking of securing a new water supply.

Seattle, Wash.—Superintendent Youngs, of the water department, recommended, August 12, the expenditure of $400,000 for the improvement of the local water system.

Ballard, Wash.—A. C. Kean, W. H. Wiley and C. G. Ingalls have been appointed a committee to investigate the question of securing a municipal water supply.

Atlantic City, N. J.—The water commissioners have recommended the construction of a new water main across the meadows and a reservoir system, at a cost of $600,000.

The question of issuing bonds for constructing waterworks has been favorably voted on at the following places: Muskogee, I. T.; Vaiden, Tenn.; Malta, Ohio; Lyons Falls, N. Y.

Alton, Ill.—Council voted to unanimously adopt a recommendation of the waterworks commission to authorize the issue of bonds for acquiring a municipal waterworks system.

Brazil, Ind.—Plans are being prepared for installing an air compressor and rebuilding part of the waterworks plant, including the constructing of a gallery and the installation of meters.

Horse Creek, Ala.—Special.—Surveys are being made for a waterworks system here, by P. Byrne, cons. engr., of Birmingham. Cast iron pipe, power house, pump and boiler, valves and hydrants, pumping basin and a concrete lined reservoir will be needed.

Palatka, Fla.—Special.—This city has engaged Wm. W. Lyon, cons. engr., to make surveys, design plans and supervise the construction of a waterworks system, at a cost of $60,000, and he will soon be in the market for machinery and general contractors' supplies, including a standpipe.

Pleasant Grove, Utah—Special—Lyman & Wilson, civil and cons. engrs., advise us that they expect to build a system of waterworks here in the immediate future, involving a concrete covered reservoir made of reinforced concrete, 4,500 ft. of 8 or 10-in., 3,500 ft. of 6 or 8-in., 12,500 ft. 4-in. and 6,000 ft. 1-in. pipe and necessary hydrants, valves and specials. They will also construct a hydraulic laboratory for the University of Utah in this city. In this laboratory there will be two canals made of reinforced concrete, one 128 ft. long, 10 ft. deep and 16 ft. wide, and the other 100 ft. long, 7 ft. wide and 9 ft. deep.

CONTRACTS TO BE LET.

Stromsburg, Neb.—Bids are asked until September 5 for erecting a standpipe. C. V. Nelson, cy. clk.

Princeton, Ky.—Bids are asked until September 5 for constructing waterworks. J. N. Brewer, cy. clk.

Sudbury, Ont.—Bids are asked until September 4 for waterworks extensions. Stephen Fourier, town clk.

Fargo, N. D.—Sealed bids are asked until September 4 for water main extensions. H. J. Gibson, cy. audt.

Brookside, Ohio—Bids are asked until September 2 for supplying this village with water. John C. Curtiss, vil. clk.

Carbon Hill, Ala.—Bids are asked until September 4 for building a waterworks plant. B. B. Guthrie, town clk.

Burlington, N. J.—Bids are asked until Sept. 19 for a pumping engine. George A. Allinson, supt. bd. water comrs.

Barnesville, Minn.—Bids are asked until September 2 for constructing a waterworks system. M. P. Phillipi, cy. clk.

Wilmington, Del.—Sealed bids are asked until September 4 for constructing a reservoir. Theodore A. Leisen, ch. engr.

Cincinnati, Ohio—Bids are asked until September 15 for laying 5,950 ft. of c. i. water pipe. Robt. V. Foster, clk. comrs. w. w.

Vancouver Barracks, Wash.—Bids are asked until September 21 for constructing a reinforced concrete water tank. Const. Q. M.

Glendive, Mont.—Bids are asked until Sept. 25 for constructing a waterworks and sewerage system. H. J. Halvorsen, cy. clk.

Brooklyn, N. Y.—Bids are asked until September 6 for 2 pumping engines, lay-

ing water mains, etc. John T. Oakley, comr. water supply, etc.

Thief River Falls, Minn.—Bids are asked until September 4, extension of date, for a power and a deep well pump. O. Clausen, cons. engr., St. Paul.

Attleboro, Mass.—Bids are asked until October 12 for a wrought iron standpipe which this city desires to dispose of. Geo. H. Snell, supt. water comrs.

Dover, Pa.—Bids are asked until September 6 for pipe and laying, tower and tank, power house and engine, specials, valves and boxes. Jacob H. Kann, town clk.

Philadelphia, Pa.—Sealed bids are asked until September 6 for the improvement, extension and filtration of the water supply. A. Lincoln Acker, dir. pub. wks.

Norfolk, Neb.—Sealed bids are asked until September 7 for the extension of water pipes and locations of fire hydrants. John C. Spellman, chmn. pub. wks. com.

Galveston, Texas—Bids are asked until September 21 for the mechanical equipment for a pumping station at Alta Loma. H. C. Lange, comr. w. w. and sewerage; C. G. Wells, cy. engr.

Niagara Falls, Ont.—Bids are asked until September 2 for installing a pumping unit, consisting of a centrifugal pump connected to a motor. James Butters, secy. bd. water comrs.

Toronto, Ont.—Bids are asked until September 19 for installing 2 5,000,000 gal. turbine pumps and steam turbines; also, for the supply of fire hydrants, valves and c. i. pipe. Thos. Urquhart, mayor.

Toledo, O.—Sealed bids are asked until September 7 for constructing section No. 2 of the filtered water conduit, which will be 2,900 ft. in length and of concrete. John Stollberg, prest. B. P. S.

Columbus, O.—Sealed bids are asked until September 14 for furnishing and erecting the machinery and equipment for the Scioto River pumping station, in Franklin twp. Chas. H. Frank, secy. B. P. S.

Salt Lake City, Utah—Sealed bids are asked until September 4 for constructing a reinforced concrete conduit, to be known as Big Cottonwood conduit. E. A. Wall, chmn. B. P. W.; Geo. W. Riter, cy. engr.

Richmond, Va.—Sealed bids are asked until September 5 for constructing a steel reinforced concrete conduit one mile long; furnishing 36 or 42-in. c. i. pipe, one mile long, and connections therefor; laying pipe. Chas. E. Bolling, supt. W. W.

Ames, Ia.—Bids are asked until September 4 for extending the waterworks system, involving about four miles of water mains, with valves, hydrants, etc.; steel tank and water tower; concrete surface reservoir; 10-inch cased well; electric deep well pumping plant, etc. A. B. Maxwell, cy. clk.

Franklin, Tenn.—Bids are asked until September 2 for $65,000 coupon bonds, 20-30 years, for building a gravity system of waterworks. Proposals for constructing the waterworks will be received about ten days later. H. P. Fowlkes, recorder; Kirkpatrick and Johnson, engrs., Jackson, Miss.

CONTRACTS AWARDED.

Turin, N. Y.—The contract for constructing waterworks was awarded to J. J. Siegrist, of Utica, for $14,000.

Jacksonville, Ill.—Mortimore Van Houten was awarded the contract for building the pumping station here for $11,956.

Mascoutah, Ill.—R. W. Stookey, of Belleville, was awarded the contract for constructing a waterworks system for $9,000.

Cincinnati, O.—The contract for laying water mains in Eggleston ave. and Ninth st. was awarded to the Keeling & Ridge Co., for $44,742.

Columbia, S. C.—The contract for constructing the waterworks system was awarded to George O. Tenny, of Spartanburg, for $153,694.40.

Colville, Wash.—The contract for constructing the new waterworks system was awarded to Naylor & Norlin, of Lewiston, for $11,825.

Bloomington, Ill.—The contract for constructing the new water reservoir was awarded to the Crescent Stone Co., of Peoria, for $34,000.

Trinidad, Colo.—T. J. Murphy, of this city, was awarded the contract for laying 7,000 ft. of new water main near the reservoir, for $15,981.

Allegheny, Pa.—The contract for a new manifold system at the Montrose pumping station was awarded to the International Construction Co. for $56,522.75.

Troy, N. Y.—The contract for constructing a permanent opening through the Tomhannock dam at Pittstown was awarded to the J. W. Bishop Co., of Worcester, Mass., for $24,360.50.

Brooklyn, N. Y.—The contract for rebuilding the Massapequa pumping station at Massapequa, L. I., through which this boro secures its water supply, has been awarded to Michael J. Dady, for $327,850.

Oneida, N. Y.—T. D. Allen & Co., of this city, were awarded the contract for constructing the new dam and impounding reservoir to increase the city water supply, as follows: Dam, $17,914; pipe line, $7,691.35; clearing and reservoir, $4,224.

BRIDGES.

Benton, Tenn.—The county has decided to build six new bridges.

Lawton, Okla. Ter.—Contracts will be let about November 1 for building thirty bridges.

Colusa, Cal.—Bids are asked until September 6 for constructing two steel bridges across Stone Corral creek. Bd. supvrs.

Lexington, Ky.—This city will vote in November on the question of issuing $27,000 viaduct bonds.

Neosho, Mo.—Bids are asked until September 4 for building a steel bridge over Indian Creek road. John M. Sherwood, bridge comr.

Aberdeen, Wash.—Council decided, August 16, to advertise for bids for building a steel bridge across Wishkah river.

Albany, Ore.—Bids are asked until September 8 for building a wagon bridge across Santiam river. B. M. Payne, co. clk.

Barberton, O.—Action on the proposed viaduct at Cornell st. crossing has been postponed until September 18. Mayor Miller.

Norristown, Pa.—Bids are asked until September 2 for building a stone bridge over Indian creek, Franconia twp. Co. comrs.

Port Huron, Mich.—The committee on bridges reported in favor of building a new bridge over Black river, at Military st.

Delaware, O.—Bids are asked until September 7 for building a bridge over Delaware river, on Sandusky st. F. D. King, clk. B. P. S.

Richmond, Ind.—The South Side Im-

provement Association has petitioned for the construction of a bridge over the Whitewater river, at H st.

Pensacola, Fla.—Bids are asked until October 1 for building a steel bridge across Perdido creek, near Muscogee. A. M. McMillan, co. clk.

South Akron, O.—The county commissioners will take formal action in September on the petition of the South Akron citizens for the proposed Kenmore bridge.

Antietam, Md.—Bids are asked until September 8 for constructing stone bridges on the Antietam battlefield. Capt. A. W. Wuatemaster, U. S. A., Washington.

Paulding, O.—Bids are asked until September 8 for building an iron bridge with concrete abutments, across Flat Rock creek. J. S. McKenna, prest. bd. co. comrs.

Norwalk, O.—Bids are asked until September 7 for repairing substructure and building new superstructure for a bridge over Huron river. J. H. Beattie, co. clk.

Washington, D. C.—Bids are asked until September 16 for constructing a concrete bridge on Sixteenth st., extended, over Piney branch. H. B. F. MacFarland, chmn. Dist. comrs.

Chicago, Ill.—Bids are asked until October 4 for building the substructure and superstructure of a bridge across the Chicago river. Zina R. Carter, prest. bd. trustees sanitary dist.

Springfield, Ill.—Bids are asked until September 4 for constructing two reinforced concrete bridges on pile foundations in Washington Park. Arthur Haym, secy.-engr. park bd.

New Albany, Ind.—Bids are asked until September 8 for constructing a bridge at Wheeler's Ford, in Lafayette twp., and at Georgetown, Georgetown twp. Thos. Hanlon, co. audt.

Chicago, Ill.—Sealed bids are asked until October 25 for building a concrete dock along the water front of the W. C. Seipp Building, on the south side of Van Buren st. and the east side of the Chicago river. Zina R. Carter, prest. bd. trustees sanitary dist.

STREET LIGHTING.

Hartland, Wis.—An electric light plant is contemplated. H. W. Goodwin, prest.

Greenwood, Wis.—This city voted to issue bonds for a municipal lighting plant.

Freeburg, Ill.—The village bd. has decided to erect a municipal light and power plant.

New York Mills, N. Y.—An electric light plant is contemplated for Upper New York Mills.

Bonner's Ferry, Idaho—The question of an electric light plant is again being discussed.

Knoxville, Tenn.—Bids are asked until September 11 for lighting this city. Wm. Epps, chmn. B. P. W.

Carbon Hill, Ala.—Bids are asked until September 4 for a light plant. B. B. Guthrie, town clk.

Burlington, Wis.—Bids are asked until September 5 for erecting an electric light plant. Cy. clk.

Camden, N. Y.—Specifications have been filed for erecting the power house for the electric light plant.

Newport, Ky.—This city will vote in November on the issue of bonds for constructing an electric light plant.

La Grange, Ga.—Bids are asked until September 15, extended from September 5, for constructing an electric light plant.

Morrison, Ill.—The contract for a new gas plant has been let to the Frank S. Moses Co., of Trenton, N. J., for $50,000.

Sullivan, Ind.—A franchise has been granted to Chas. E. Draper, of this city, for erecting and operating a gas plant.

Washington, D. C.—Bids are asked until September 30 for a heating, lighting and power plant. Elliott Woods, supt. U. S. Capitol bldg. and grounds.

Indianapolis, Ind.—Council has ratified the contract with the Cleveland Street Lighting Co. for gas and naphtha lights.

Monroe, Mich.—A resolution was passed August 12 providing for the sale of the municipal lighting plant to the General Construction Co., Ltd., for $25,000, 10-yr. contract and franchise; lights at $56 per year.

GARBAGE DISPOSAL, STREET CLEANING AND SPRINKLING.

Paducah, Ky.—The construction of a garbage crematory is contemplated.

Union Hill, N. J.—The contract for the removal of ashes was awarded to A. Roscillo, of New Dunham, for one year, for $2,450.

Kansas City, Mo.—The contract for the collection of the city's garbage was awarded to L. P. Elberg, of this city, at $3,000 per month for the summer months and $1,578 per month for the winter months, making a total of $27,504 for the year.

Indianapolis, Ind.—Bids were received August 21 for the collection, removal and disposal of all garbage and dead animals and the disposal of night soil, as follows: Marion County Construction Co., $53,820 a year; Indianapolis Reduction Co., $57,970; F. T. Edenharter, $70,980. The bids were for a ten-year contract. Bids for ash collection were as follows: H. W. Miller and W. J. Robison, $23,500 a year; Kennington Brothers, $39,500; C. C. Jones, $30,000; Marion County Construction Co., $31,500; Indianapolis Sanitary Co., $29,500. S. K. Ruick bid $34,000 for the first year, with an increase of $1,000 a year until the tenth year, the service then to cost $44,500.

FIRE APPARATUS.

Montreal, Can.—Special.—T. A. Morrison & Co., 204 St. James st., are in the market for fire apparatus.

Albany, N. Y.—Bids are asked until September 12 for the construction of a fire alarm system for the East Side. Cy. clk.

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